POWER

Vol. 47 NEW YORK, FEBRUARY 19, 1918 No. 8

The Secret

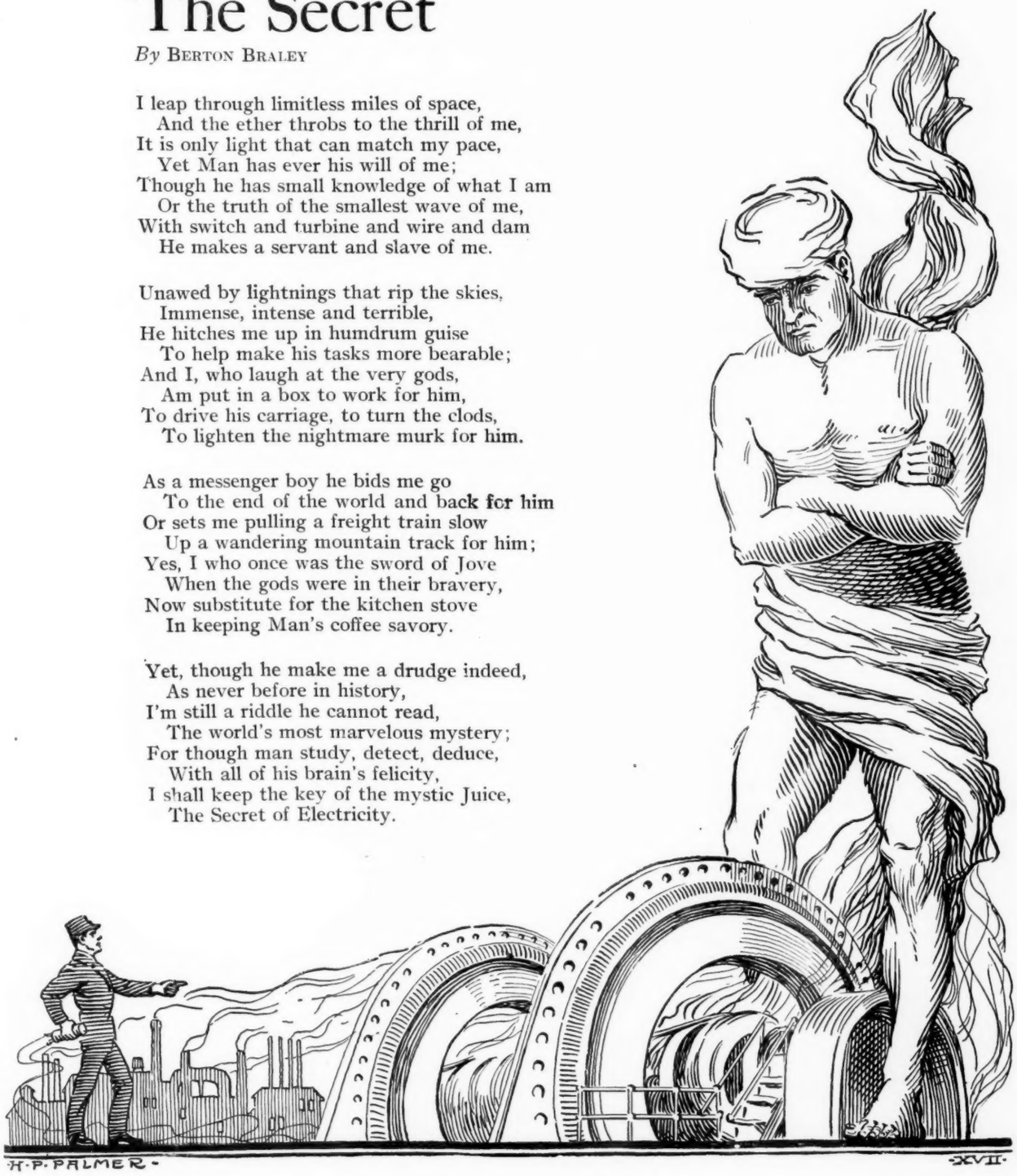
By BERTON BRALEY

I leap through limitless miles of space,
And the ether throbs to the thrill of me,
It is only light that can match my pace,
Yet Man has ever his will of me;
Though he has small knowledge of what I am
Or the truth of the smallest wave of me,
With switch and turbine and wire and dam
He makes a servant and slave of me.

Unawed by lightnings that rip the skies,
Immense, intense and terrible,
He hitches me up in humdrum guise
To help make his tasks more bearable;
And I, who laugh at the very gods,
Am put in a box to work for him,
To drive his carriage, to turn the clods,
To lighten the nightmare murk for him.

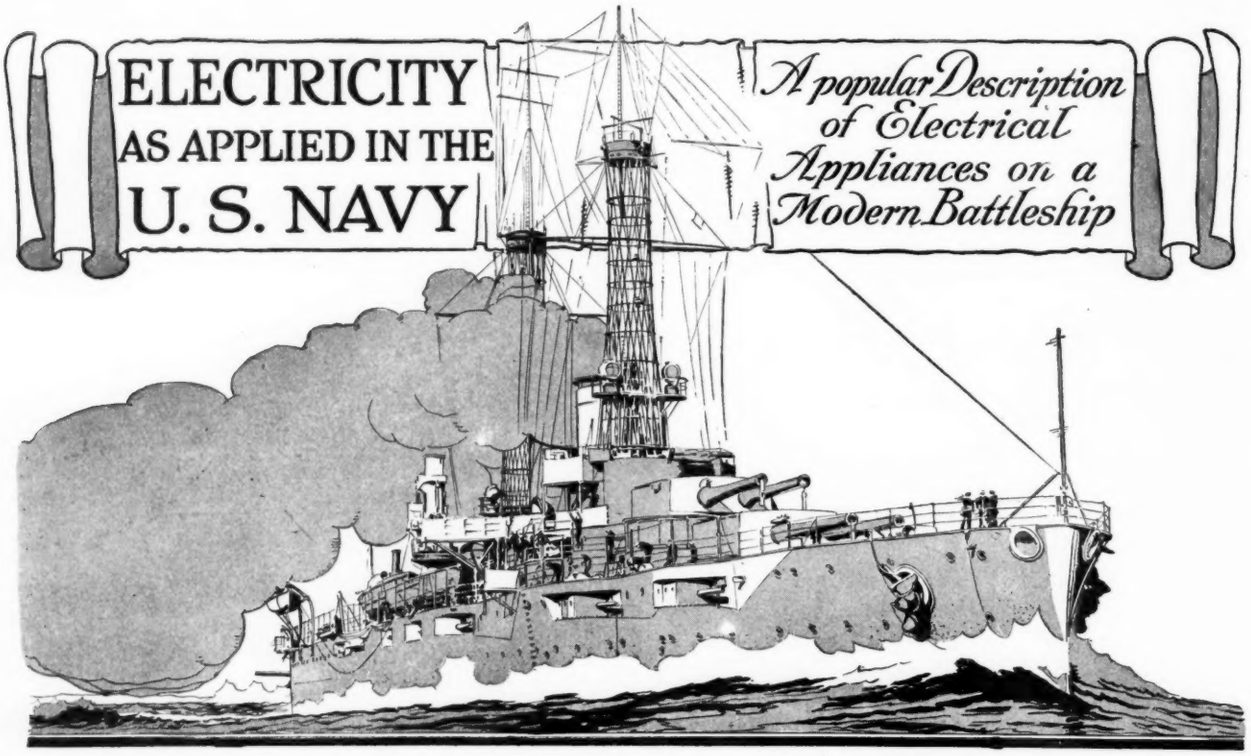
As a messenger boy he bids me go
To the end of the world and back for him
Or sets me pulling a freight train slow
Up a wandering mountain track for him;
Yes, I who once was the sword of Jove
When the gods were in their bravery,
Now substitute for the kitchen stove
In keeping Man's coffee savory.

Yet, though he make me a drudge indeed,
As never before in history,
I'm still a riddle he cannot read,
The world's most marvelous mystery;
For though man study, detect, deduce,
With all of his brain's felicity,
I shall keep the key of the mystic Juice,
The Secret of Electricity.



ELECTRICITY AS APPLIED IN THE U. S. NAVY

A popular Description of Electrical Appliances on a Modern Battleship



UNTIL recent years the application of electricity to the operation of the various devices on board ship has been slow. This has been true of marine work in general. The most conspicuous exception to this rule has been in the American Navy, which is not only a larger user of electrically driven machinery than the merchant marine, but also leads the navies of the world in the application of electricity to the almost countless devices used on board a modern battleship.

The employment of electricity on shipboard was at first limited to illuminating purposes and searchlights. On the cruiser "Brooklyn," which was launched in 1895, electric motors were used to drive the ammunition hoists and for turning two of the turrets, but it was not until the launching of the battleships "Kearsarge" and "Kentucky" in 1898 that an extensive use of electrically driven auxiliaries began. Since then the use of electricity has been extended until today some of our largest and most powerful superdreadnaughts and battle cruisers are electrically driven. As an illustration of this, the superdreadnaught U.S.S. "Tennessee," which has a displacement of 32,600 tons and is designed for a speed of 21 knots per hour, will be driven by four alternating-current motors, one on each propeller. Each motor will have a normal capacity of 6700 hp. and a 25 per cent. overload rating, or 8375 hp. for four hours. Power will be supplied by two 13,500-hp., standard steam turbo-alternators similar to those used in large power houses throughout the country

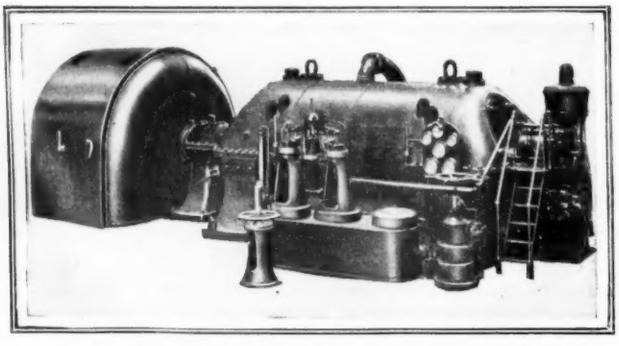


FIG. 1. STANDARD STEAM TURBO-ALTERNATOR

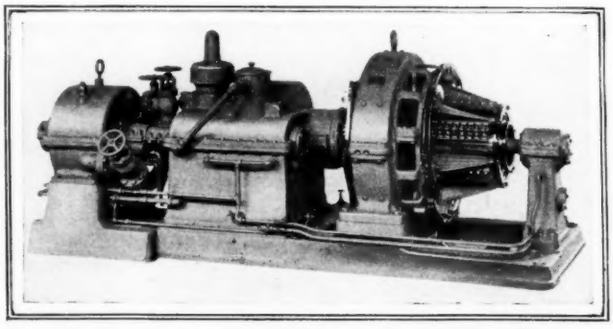


FIG. 2. GEARED-TURBINE, DIRECT-CURRENT GENERATOR

(Fig. 1). In addition to the main generators there will be six 300-kw. direct-current geared-turbine-driven auxiliary units, similar to that shown in Fig. 2, to furnish current for exciting the alternators and for light, power, signals and several hundred motors used about the ship. This equipment was described in *Power*, Aug. 7, 1917 issue.

The first ship of any importance, excepting submarine boats of the navy, to be electrically driven was the U. S. collier "Jupiter," which was built at the Mare Island Navy Yard and put in commission Sept. 15, 1913. This vessel is of about 20,000 tons displacement and is designed to carry 12,000 tons of coal or oil. The main units of this boat consist of one alternating-current turbo-generator set of 7000 hp. and two 3500-hp. wound-rotor induction motors, wound for 3400 volts. The

stator and rotor of one of the motors are shown in Figs. 3 and 4 respectively.

The electrical installation on board a modern battleship may be divided into three general systems—power, lighting and signaling. Outside of the main drive, when the vessel is electrically driven, the power plant usually consists of a number of 300- to 375-kw. turbine-driven 125- or 250-volt direct-current generators, although in some of the oldest ships 80-volt equipments are used. As pointed out in a previous paragraph, the superdreadnaught "Tennessee" will have six 300-kw. direct-current units in the auxiliary power plant. The generators of the earlier equipment were direct-connected to the turbine, ran at a speed of 1500 r.p.m. and were of the compound-wound type with commutating poles. In the more modern equipments geared turbines are used and the generator operates at from 700 to 1000 r.p.m. On account of the comparatively heavy current and small diameter of the commutator, the 125-volt units generally have two commutators, one at each end of the armature.

It is general practice to provide not less than four of these sets and locate them in two separate dynamo rooms, so that in case of the disablement of one dynamo room the entire electrical equipment will not be put out of business.

The method of operating the generators varies somewhat with different nations. In America it is general practice to operate them in parallel, while in Europe in many cases the generators are arranged so that the distributing circuits can be transferred from one generator to another, but the generators cannot be operated in parallel.

Figs. 5 and 6 show the back and front view of a switchboard used for the control of the direct-current power plant on a modern battleship. On the center panels are mounted the switches, circuit-breakers, instruments, etc., for the control of two generator sets, either or both of which may be connected to the busbars. The end panels are for the control of the distributing circuits. Circuit-breakers are used to protect the large-capacity circuits, while fuses are used on the smaller circuits. Where the power plant is divided and located in different rooms, tie lines are provided between the different switchboards so that the machines in one generator room may supply power to busbars of the switchboard located in the other room. In addition to the main switchboard other distributing panels are located in the various parts of the ship for the control of motors and distribute the current to the various equipments.

FIG. 4. ROTOR OF THE STATOR, FIG. 3

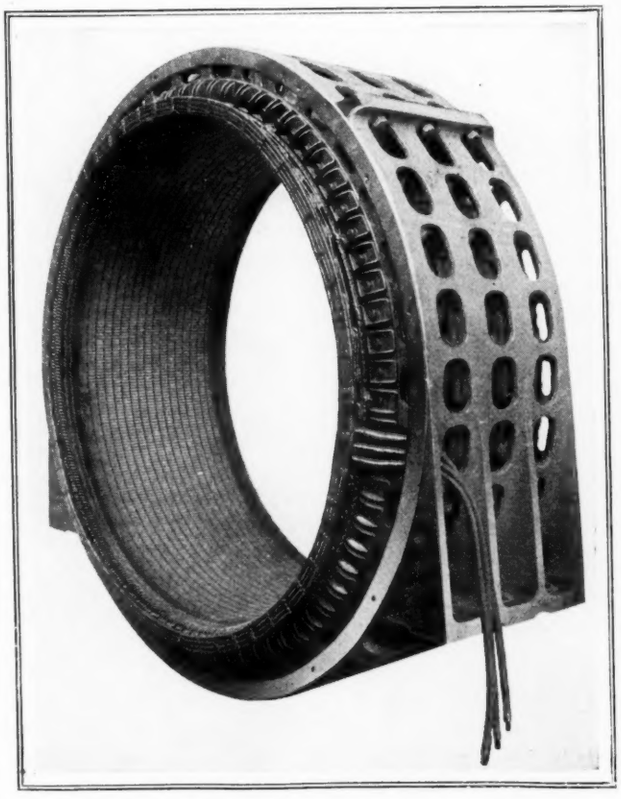


FIG. 3. STATOR OF ONE OF THE JUPITER'S MOTORS

In America the earlier practice was to construct the switchboard panels of slate mounted on angle-iron supports, and sometimes cushioned with rubber to prevent breakage. The more modern practice is to construct the panels of nonfragile insulating material, such as asbestos lumber. In Europe the panels are frequently made of steel with the instruments insulated therefrom.

The largest and one of the most important applications of electricity on board ship is the steering gear. The operation of the steering gear by some power means dates back to the "Great Eastern," on which was placed a steam-operated steering equipment. The success of this installation soon led to the general adoption of steam-operated steering gears on most all classes of vessels. Although electrical steering gears have been given attention for some twenty or twenty-five years past, it is only within recent years that they have been adopted in general. At first they were applied in conjunction with steam engines, the electrical drive acting as an auxiliary.

One of the first systems to be successfully employed,

utilized a motor-generator set to supply power to a shunt motor for operating the rudder. Control with this system was effected on the Wheatstone-bridge principle and is known as the "Pfatischer" system, one arm of the rheostat being located at and operated from the steering stand and the other located at and operated by the rudder.

This system followed along the idea of the old follow-up system, used with the steam engine; that is, the helmsman sets the steering wheel at the angle it was desired to have the rudder moved to, and when the latter arrived at this position it automatically cut out the source of driving power.

Quite a number of the United States battleships and cruisers are equipped with a rheostatic system of control on the steering gear. The motor is fed directly from the ship's mains, thus obviating the use of a motor-generator set. With the rheostatic control the motor is controlled by the use of a contactor panel, Fig. 7, equipped with contactors for reversing the motor, cutting out the armature resistance, for operating at slow speeds and for dynamic braking. The controller, along with the starting resistance, is usually placed near the motor and operated from a steering stand, Fig. 8, located at steering stations in different parts of the ship. The helmsman can always tell the position of the rudder by a helm-angle indicator located near the steering stand. To prevent the rudder from jamming on the hard-over position, limit switches are provided similar to the one shown in Fig. 9.

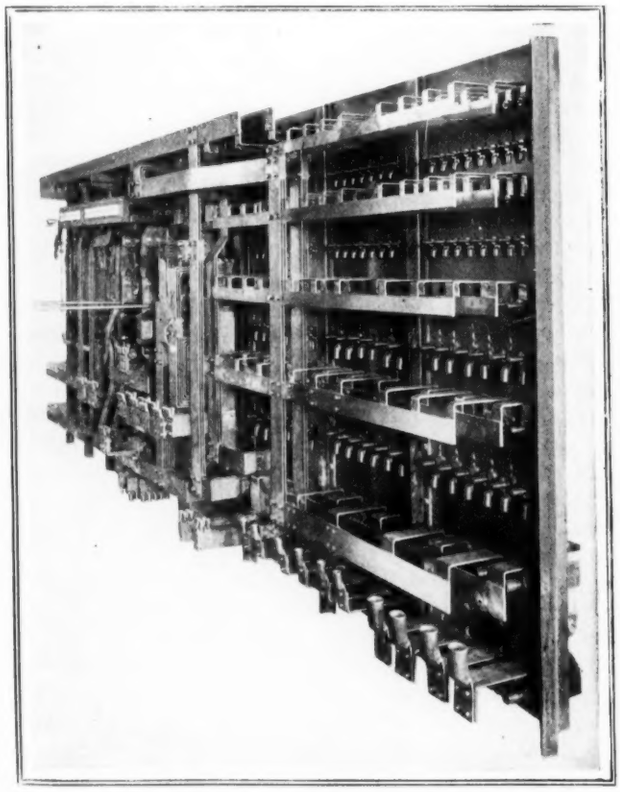


FIG. 5. BACK VIEW DIRECT-CURRENT SWITCHBOARD

The system which is now receiving favorable consideration at the hands of the Navy Department involves the use of a hydraulic mechanism to operate the rudder. A variable-stroke hydraulic pump delivers oil to large rams connected to the rudder crosshead, and this variable-stroke pump is driven by a constant-speed motor, which is started up and allowed to run continuously. A small pilot motor operates the valve of the hydraulic variable-stroke pump, and the control of this pilot motor, from various stations in the ship, is the same as the rheostatic system described in the foregoing.

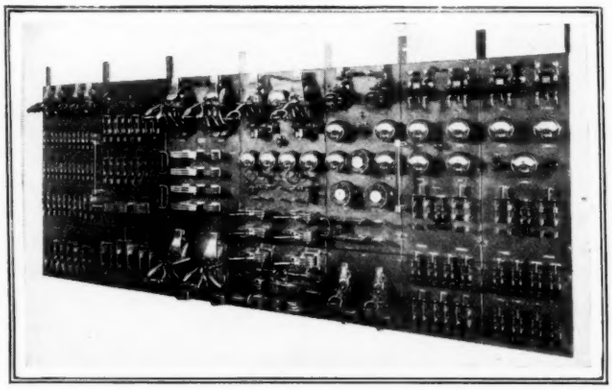


FIG. 6. FRONT VIEW DIRECT-CURRENT SWITCHBOARD

While this hydraulic-electric steering-gear system may be said to be still somewhat in the experimental stage, it is being installed at the present time quite generally on large naval vessels. Its principal point of advantage is that it substitutes the hydraulic variable-stroke pump and hydraulic ram for the very inefficient screw-gear arrangement previously used on all the old vessels, and therefore permits the installation of a motor of relatively small horsepower for driving the rudder.

The requirement on nearly all naval vessels is that the motor must operate the rudder from hard-over to hard-over in twenty seconds. On the most recent and largest vessels, it has been modified in some cases to thirty seconds. With the rheostatic control on the larger battleships, compound-wound interpole motors of 300-hp. capacity are required to operate the steering gear, while with the hydraulic-electric the horsepower is reduced to about one-half, or 150. Fig. 10 shows a pair of 175-hp. steering-gear motors operating in parallel on a single rudder shaft. The motors are equipped with disk brakes on the armature shaft, which, assisted by dynamic braking, brings the rudder to rest.

Another service that requires large motors on board ship is the anchor windlass. On some of the recent equipment installed on American battleships, two motors are used, each having a one-hour rating of from 125 to 150 hp. The motors are compound-wound and equipped with commutating poles and a disk brake, and are coupled directly to the two worm gears through which the windlass is operated. The control of the motors is such that each can be operated independently as well as the two simultaneously in series or parallel. The equipment is capable of raising two 20,000-lb. anchors simultaneously and 360 ft. of chain on each, each chain weighing about 36,000 lb., at the rate of 36 ft. per minute.

The cranes for handling the lifeboats are operated by compound-wound motors, usually of 50-hp. capacity, one of which is shown in Fig. 11. In this equipment the requirements are that it raise a 40,000-lb. load at

20 ft. per min. and the empty hooks at 60 ft. per min. The motor is equipped with an electric brake so that it will hold the load if the power fails. A motor is also used for rotating the crane so as to place the boats in position on deck. The capacity of this motor is frequently 50 hp. A rheostatic controller for a boat-crane motor is shown in Fig. 12.

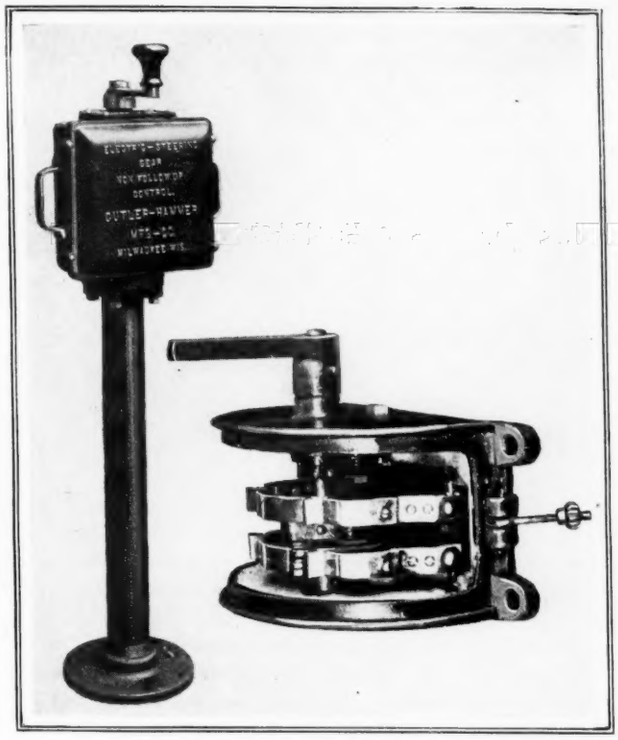
Winch motors for both coal and cargo are 35 to 45 hp. in size, compound-wound and equipped with interpoles. The winches for coal handling are generally capable of handling a 5000-lb. load at 200 ft. per min. and a 20,000-lb. load at 50 ft. per minute.

Forced ventilation is an important feature in the operation of a modern battleship. On large ships the ventilation system may consist of over one hundred electrically driven fans, handling 500,000 cu.ft. of air per minute. The size of the motors varies from 1 to 15 hp. In addition to the ventilation motors, there may be as many as 200 small desk or bracket fans in use. In the latest practice on battleships steam turbines are being used extensively for driving the ventilating fans.

Electrically driven pumps are used for various purposes, such as fire, fresh-water supply, bilge, drainage tanks, sanitary purposes, refrigeration, etc. These motors vary in size from 1 to 75 hp. To handle the bilge water 15 to 20 pumps are supplied. These pumps require vertical and horizontal motors varying in size from 25 to 75 horsepower.

Motors are used for turning the turrets, elevating the large guns and hoisting ammunition. These services require motors ranging in size from 3 to 35 hp. Variable-speed as well as constant-speed motors are used on the ammunition hoists.

FIG. 7. CONTACTOR PANEL FOR 300-HP. ELECTRIC STEERING-GEAR MOTOR



FIGS. 8 AND 9. STEERING STAND AND LIMIT SWITCH
Fig. 8—On left, electric steering stand for non-follow-up system. Fig. 9—On right, rudder limit switch

Electricity is used for almost every imaginable purpose on board the modern battleship. The completeness of the equipment is evident from such items as moving-picture machines, motor-driven cake mixers, ice-cream freezers, etc., which would indicate that about all the luxuries that may be had on land are also provided on board ship.

The illuminating equipment of a battleship consists of from 3000 to 4000 lights. Incandescent lamps are used almost exclusively for this purpose. The fixtures are of special design to make them water-tight and also on account of the vibration of the ship.

The cables must also be of special design on account of the moisture. They are insulated with a high-grade rubber and a suitable braid, and then protected with a lead sheath, covered with metal armor. This cable is quite flexible and can be easily made to conform to almost any contour. The electrical installation on a battleship requires from 75 to 100 miles of cable.

The signaling systems are also a very extensive part of the electrical equipment, consisting of some 40 different systems, including ammunition-hoist indicators, gun firing, turret telephone, fire-control telegraph, engine-room telegraph, fire alarms, torpedo firing, wireless telegraph, etc. A number of these equipments are installed in duplicate and are supplied with power from two sources. The systems operate on voltages ranging from the potential of the power circuit down to 15 volts used for call bells. Both alternating and direct current are used. Alternating current and low-voltage direct current are obtained from motor-generator sets.

One of the most interesting pieces of electrical apparatus on a battleship is the gyroscopic compass. This has completely displaced the magnetic compass on the larger vessels and submarines of practically every navy

in the world. The sensitive element is a rapidly revolving wheel which, owing to the peculiar effect of gyroscopic force, keeps its axis parallel to the axis of the earth and hence points to the north pole.

A magnetic compass must be corrected for the iron masses surrounding it and also for the difference between the location of the magnetic north pole and the geographic north pole. As the gyro compass is independent of magnetism, these corrections do not have to be made and calculations based on compass bearings are greatly simplified. The only corrections are for the speed of the ship and for latitude. These corrections are made semi-automatically and involve no calculations.

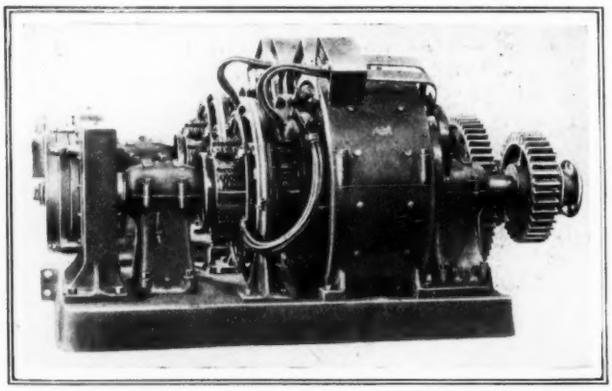


FIG. 10. PAIR OF 175-HP. STEERING-GEAR MOTORS

The complete battleship equipment consists of two master compasses, one of which is shown at *M*, Fig. 13, a number of repeater compasses *R*, a motor-generator set *G*, and a control panel *C* for running either master compass and for interconnecting the repeater compasses in any desired combination.

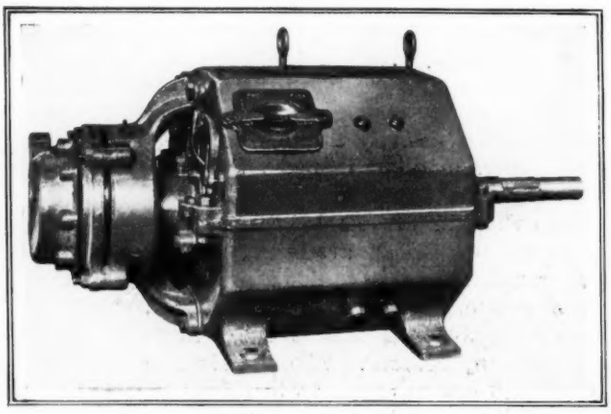


FIG. 11. BOAT-CRANE MOTOR

The repeater compasses contain small motors which are driven by a transmitter in the master compass. The master compass is mounted below deck out of all danger, while the repeater compasses are used in navigating the ship. These repeaters are mounted in different ways—on a stand similar to the ordinary magnetic compass; on the wall; on a pelorus *P*, Fig. 13, for taking azimuth sights directly; and they even may be portable so that the navigating officer may walk around and still have the compass with him.

To the layman the master compass appears to be a tremendously complicated and delicate mechanism. A detailed view of it is given in Fig. 14. Its "sensitive element" is a steel wheel *W*, with its axis horizontal, driven at 8600 r.p.m. by a self-contained three-phase alternating-current motor. This wheel runs in a vacuum to eliminate the air friction, which is very great at the high speed at which it runs. The wheel and case *W* are suspended on a steel cable, which is held at its upper end in a ball bearing. This bearing is covered by a cap which can be seen at *C* in the figure. Connected to this case through the "floating ballistic" is the compass card *D*, Fig. 15, from which the heading is read. The card is kept continually oscillating about half a degree by a small motor, to keep out any slight friction lag in the reading. The force of the gyro does not turn the card directly, but closes contacts at *T* and *T*, which causes a little motor to drive it one way or the other. The transmitting mechanism which controls the repeaters is also operated by this motor. At *W* are shown the small wheels for correcting the

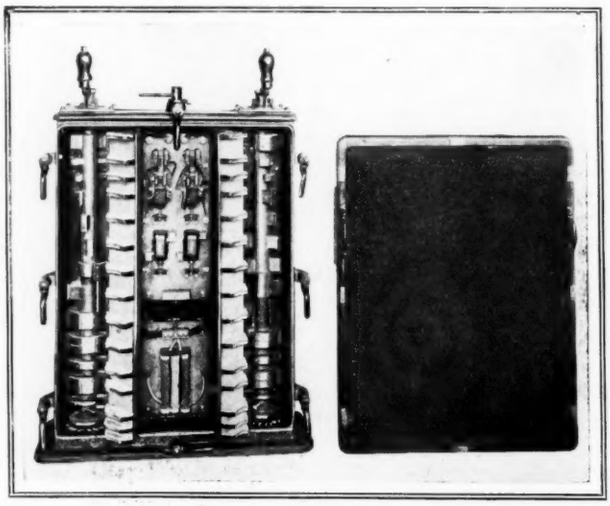


FIG. 12. BOAT-CRANE MOTOR CONTROLLER

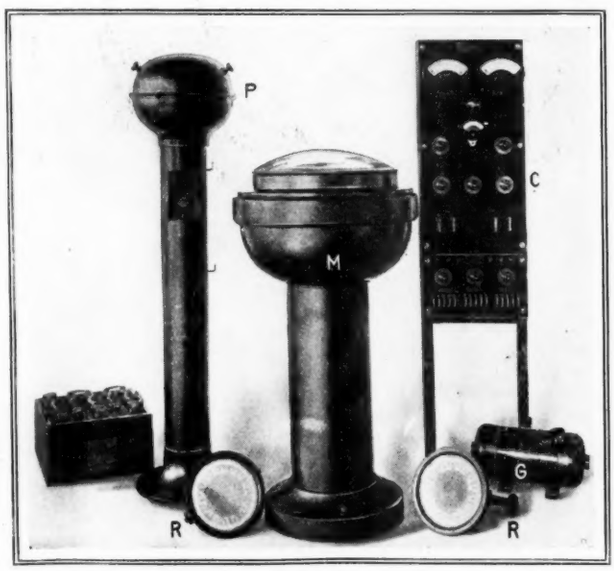


FIG. 13. GYROSCOPIC-COMPASS EQUIPMENT

compass for speed and position. These two knobs operate interconnected cams and link which automatically solve an involved trigonometric equation and make the necessary corrections.

Another interesting and important device used on warships is the high-intensity searchlight, Fig. 16. The beam from this light is the most brilliant known, being equal to the sun's intensity at 8 a.m. or 4 p.m. New York latitude. The size used on ships is 36 in. diameter and will throw a beam 40 miles.

The positive and negative electrodes are respectively 16 and 11 millimeters in diameter in this lamp. Its candlepower is 320,000 per sq.in., and in the 36-in. type it has a beam intensity of 256,000,000 cp. The temperature of the arc is about 5000 deg. C., or 9000 deg. F. The arc running at a temperature of 7000 deg. F. higher than the melting point of the carbon holders

FIG. 14. SIDE VIEW OF MASTER GYRO COMPASS

is only about one inch away from them. The positive carbon is rotated as it is fed forward, while the negative feeds forward and upward at an angle to meet the positive. The voltage of the arc is approximately 75. When focused sharply, the beam will ignite paper at a distance of approximately 250 ft. A larger size, 60 in. in diameter, used in coast-defense work, is the most powerful light in the world, having a beam of 1,280,000,000 cp. This lamp stands ten feet high and weighs three tons; newspapers may be read in its light thirty miles away. It has been reported that signals flashed by this searchlight were seen 150 miles away. The brilliant light is obtained by the use of special carbons having a deep but small crater in the positive carbon, in which the vapor burns. This gives a beam 3.5 times greater than an arc using ordinary carbons.

FIG. 15. TOP VIEW OF MASTER GYRO COMPASS

The lamp may be controlled directly by using the handwheel *W*, or it may be trained and elevated by using the remote-control lever *L*, which may be located in any part of the ship. This is a very important feature, as it is much easier to see what the light is disclosing from a point 200 ft. away from the light than from a position near the light itself. It is possible to elevate the lamp to a vertical position, making it available for anti-aircraft work. The shutter, which completely cuts off the beam, may be seen at *S*. The

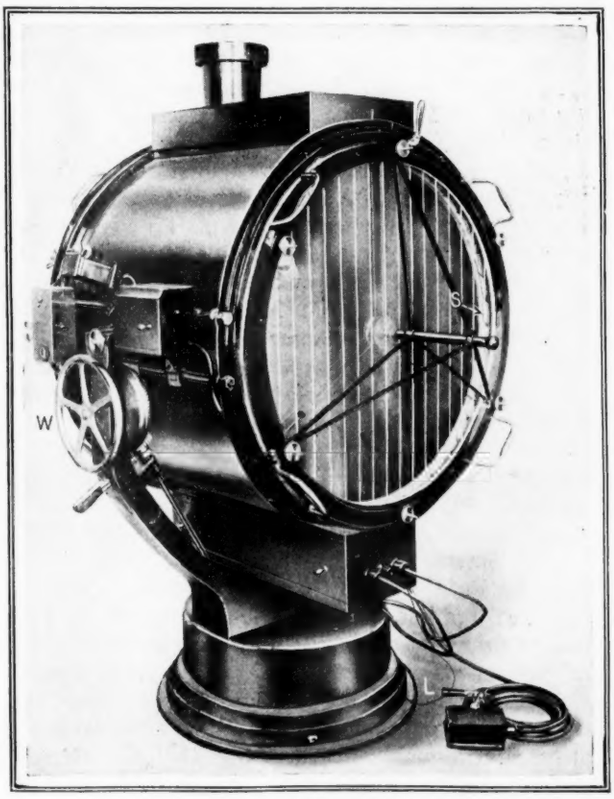


FIG. 16. THIRTY-SIX INCH SEARCHLIGHT

movement of a lever closes it tightly. This feature is very important, as a dying arc makes an excellent target. For this reason the shutter is closed previous to putting out the light, leaving the boat in complete darkness.

The arm of the Navy that is attracting more attention than any other at the present time is the submarine

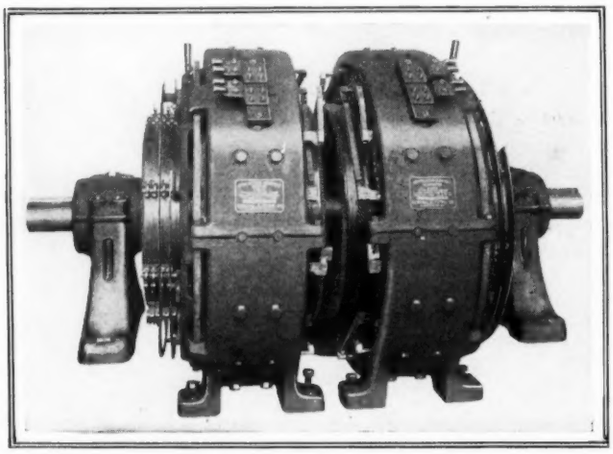


FIG. 17. PAIR OF SUBMARINE PROPELLED MOTORS

boat. Modern submarine boats are propelled by oil engines on the surface and electric motors when submerged, each propeller shaft being operated by an oil engine or motor according to the conditions of operation, the oil engines operating the motors as generators while on the surface and charging storage batteries, which in the submerged condition, supply current to the motors to drive the boats.

The main motors, Fig. 17, one on each propeller shaft, are of large size, varying from 500 to 800 hp. according to the size of the boats, and these motors are remotely controlled by automatic-contactor controllers from a central station. Each motor may consist of two units as in the figure or a single unit according to conditions.

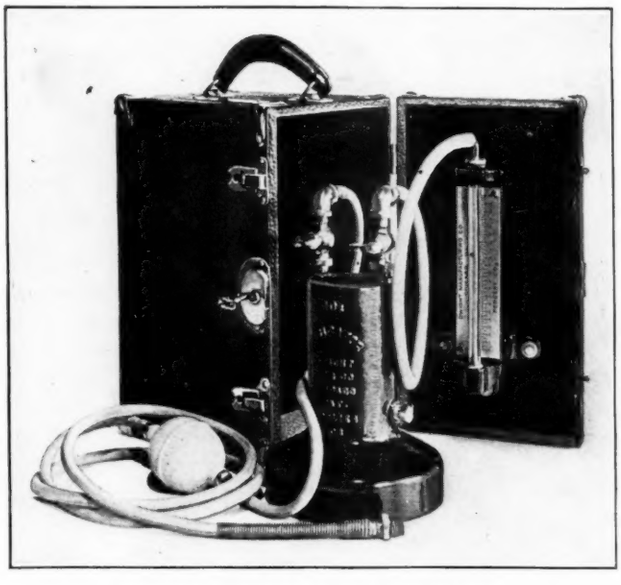
In addition to the main-motor equipments, each submarine is provided with a large number of auxiliary-motor equipments for operating pumps, air compressors, steering gears, diving gears, periscope-lifting gears, etc. The horsepower of these auxiliary equipments varies from about 0.5 to 50 or 60 hp., and the majority of them are operated by contactor push-button controllers. In addition, the submarines are equipped with electric cooking and heating devices and complete sets of wireless and other signaling apparatus.

[Considerable of the material in this article was compiled from articles in the *General Electric Review:* February, 1914, "Electric Propulsion of the U.S.S. 'Jupiter,'" by W. L. R. Emmett; and June, 1915, "Electricity in Marine Work," by Maxwell W. Day. "Electricity the Future Power for Steering Vessels," by H. L. Hibbard, Transactions of the A. I. E. E., Vol. XXXIII, was also drawn upon. This material has been added to when necessary to bring it up to date. The descriptive literature of the Sperry Gyroscope Co. was also consulted. Photographs were supplied by the Westinghouse Electric and Manufacturing Co., the General Electric Co., Cutler-Hammer Manufacturing Co. and the Sperry Gyroscope Co.—Editor.]

Mercury Column Indicates CO_2

The Dwight Manufacturing Co., of Chicago, has added to its line a second form of CO_2 indicator. The use of a mercury column calibrated to indicate directly the percentage of CO_2 is the distinguishing feature. The initial design, which is still retained, used a small spring-type gage for this purpose. Both types are accurate and so rapid in operation as to encourage the consistent use necessary to produce a material saving in coal.

The new instrument, known as type B, is shown in the illustration. It consists of the usual metal reservoir, a specially calibrated mercury gage and the carrying case for the complete outfit. When in service the reservoir is disconnected from the gage and a sample of flue gas pumped through the chamber. A comparatively large supply of potash solution fills the base, and on the surface of this solution floats a layer of mineral oil sealing from the chemical the gas sample being collected. When the gas sample has been obtained, both valves on top of the instrument are closed and the reservoir is shaken back and forth a few times to break the oil seal and allow the chemical solution to absorb the CO_2 from the gas sample. This "splash system" of mixing the gas and liquid produces rapid absorption of the CO_2 on account of the large surface area of fresh chemical brought in contact with the gas. Connection is then made with the mercury gage, as shown in the illustration, and upon opening the communicating valve the percentage of CO_2 in the gas is indicated on the gage.



MERCURY COLUMN CO_2 INDICATOR

In the design proper precautions were taken to trap the mercury so that it cannot spill even when the apparatus is inverted. The graduated scale is movable so that the zero point can be easily set opposite the mercury level when the gage is under atmospheric pressure.

The Canadian Commission of Conservation estimates the total possible water-power resources of the Dominion at 18,803,000 hp., while the developed water power is 1,813,210 hp.—*Commerce Reports.*

The Fifty-Thousand Kilovolt-Ampere Connors Creek Turbines

BY C. F. HIRSHFELD*

Largest single-cylinder turbine. The first of two units now being installed, each to be served by four 2365-hp. boilers. With 70,000 sq.ft. of surface the condenser is the largest yet attempted in a single shell. It has but one water pass, and drain plates spill the condensate into the steam belt, so that its temperature at the hotwell will approximate that corresponding to the vacuum.

THE Connors Creek plant of the Detroit Edison Co. was planned to contain six 25,000-kv.-a. 60-cycle machines supplied with steam from twelve 2365-hp. boilers operating at 225 lb. gage pressure and 200 deg. superheat at 200 per cent. of rating. The first unit was started Feb. 8, 1915; the second July 7, 1915, and the third Feb. 15, 1917. When the fourth unit came up for consideration, it became evident that the development of large turbine units and likewise the growth of the company's load had progressed to such a point that it would be desirable to choose a unit of greater capacity than originally planned. It was then decided to complete the plant by installing two 50,000-kv.-a. machines instead of the three 25,000-kv.-a. units originally contemplated. One of these larger units is now being placed.

EACH TURBINE SUPPLIED BY FOUR BOILERS

Each of these machines will be supplied with steam from four boilers[1] similar to those originally planned, so that the ratio of boiler capacity will not be altered. However, the change involves the ultimate installation of eight boilers instead of the six which would have been required to serve three 25,000-kv.-a. machines. The ultimate capacity of the station as now planned will be 175,000 kv.-a. instead of 150,000 as originally intended.

The turbine for the large unit is of the disk type and represents a development of the design used in the first machines installed in the station. It has 21 stages as against nine in the smaller machines. However, in spite of this fact and also in spite of its larger capacity, the new unit is only fifteen feet longer, over-all, than are the smaller machines. Other dimensions are also much smaller than one would expect from a direct comparison of capacities. The weight is only about 40 per cent. greater than that of the earlier models. The speed, 1200 r.p.m., is the same.

The small physical size in comparison with the earlier units is partly due to refinements in the design of the turbine which have made it possible to greatly decrease the distance between wheels. It is also due in a small degree to higher generating voltage, 12,200 instead of 4600.

The best indication of the tremendous capacity that has been incorporated in a single turbine barrel, and in a single generator, is given by the size of the exhaust opening. This is rectangular and measures 12 x 18 ft. in the clear.

Longitudinally, the barrel is made in two sections. The low-pressure section is of cast iron and is rigidly bolted to the concrete foundation. The high-pressure section is of cast steel and is bolted to the high-pressure end of the low-pressure section. It is hung free of the foundation between the low-pressure casing and the bearing on the high-pressure end of the turbine. It is thus free to expand radially in all directions. At the high-pressure end the bearing is held in guides in such a way that it can slide longitudinally under the effects of varying temperatures.

The unit is supplied with steam through two lines, each 14 in. diameter. These two lines run together in a special, cast-steel, inverted-Y fitting which carries the steam up to the turbine throttle. The exit of the inverted Y, that is, the vertical leg, has an internal diameter of 20 in. While the unit is nominally served by the four boilers located opposite it, crossover headers are so arranged that any of the boilers in the plant can supply it with steam. In practice these crossover headers are always open so that practically all the simplicity of a unit layout is obtained with the security characteristic of a collective layout.

The steam exhausted by the turbine passes directly downward through a short expanding neck into the condenser. This condenser contains approximately 70,000 sq.ft. of surface made up of 1-in. tubes with a length of 24 ft. The tube sheets have a diameter of about 15.5 ft. in the clear, which gives sufficient area to permit the use of numerous generously proportioned lanes to lead the steam to all parts of the surface. This action is assisted by a steam belt which is obtained by setting the tube sheet eccentric in the shell. The steam belt is so shaped and located that it connects the exhaust nozzle with the space directly over the hotwell. This will be referred to later.

LARGEST SINGLE-SHELL CONDENSER

This condenser, like the turbine, is the largest yet attempted in a single shell. It is also unique among condensers of this general class, in that it is arranged for but one water pass. The circulating water enters all the tubes at one end and leaves all at the other end, flowing away over a dam the crest of which is so located as to submerge the highest tubes.

It was feared that with a condenser containing such a deep mass of tubes as this one and with all the tubes carrying cold water, the condensate would be abnormally cooled before arriving at the hotwell. For this reason devices which have been called drain plates were installed. These have been tried in various forms in smaller condensers in the older, or Delray, plant of the company and have been found very satisfactory.

Drain plates are formed by placing light-weight metal plates in the steam space in such positions as to catch the condensate from the upper sections and lead it

*Chief of research department, Detroit Edison Co.

[1]For description of initial installation see "Power," Sept. 14, 1915, pp. 388-396.

to the bottom of the condenser without allowing it to come in contact with the tubes in the sections through which it is led. These plates are not intended as steam guides or baffles, and their successful use depends on placing them in such positions that they do not interfere in any manner with the free flow of steam.

In the condenser under discussion the plates are arranged in such a way that the condensate is spilled directly into the steam belt in streams of comparatively small cross-section. It then flows toward and into the hotwell in contact with the steam in this belt. Provision is made to prevent a collection of air over the hotwell and at the lower end of the steam belt, and it is hoped that the condensate will enter the hotwell at a temperature very near that corresponding to the vacuum even under winter conditions.

The condenser is served by two hotwell pumps, either of which has sufficient capacity to handle all condensate made at full load. There are also two circulating pumps. These are 48-in. double-suction pumps and are driven by variable-speed direct-current motors. Each pump has a capacity of 60,000 gal. per min. and can therefore pass sufficient water to condense all steam used at the most economical turbine loading. The second pump will be required only at maximum output, or when the circulating water is above a normal temperature.

The air pump is of the rotative dry-vacuum type and is driven by a variable-speed, direct-current motor. It is arranged for two-stage operation in a single cylinder and has a diameter of 39 in. and a stroke of 30 in.

Coal-Pit Mouth Power Plants

By D. A. Shearer

The present abnormal conditions direct attention to the apparent economy of operating steam-power plants at the coal mines. Long-distance electrical-power transmission has long since passed the experimental stage, and lines carrying hydro-electric power many hundred miles furnish indisputable evidence of the practicability of so distributing power over a large territory.

It has been stated that 35 per cent. of the freight handled by the railroads consists of coal, only 15 per cent. of which is for domestic requirements. This means that the transportation of coal for power purposes is one of the big factors in the high cost of power and is moreover one of the causes of the present great freight congestion. It seems therefore that the establishment of many large central stations directly in the coal fields would mitigate this serious economic condition. The coal fields are situated in a comparatively central position relative to the manufacturing centers of the Eastern States and are within an economical transmission distance if electrical energy is used. By the use of large boiler capacity and large generating units a high degree of efficiency could be achieved and a network of high-voltage large-capacity transmission lines could be extended over the entire eastern part of the United States. This would relieve the railroads of much congestion, dodge labor troubles on the transportation systems, prevent much coal waste in hauling, probably increase the efficiency of many manufacturing plants and would lead to the electrification of many steam railways, with a further saving of coal. The entire output of all grades from any mine could be economically and efficiently changed to electric power.

The coal question will not be settled with the cessation of war, for it is a problem that will remain with us and grow more acute with years. The war has only been the means of drawing attention to economic problems in a pressing manner and a little ahead of the normal schedule. The problems were there before the war and will remain after it is ended, to be considered and perhaps solved by a future if not by the present generation. If the proposed development was in operation now, there would be no coal shortage.

Energy in Revolving Flywheel

To calculate approximately the energy stored in a revolving flywheel, first ascertain (by calculation) the weight of the rim (weight of spokes, etc., is usually disregarded) and its velocity in feet per second (at the given r.p.m.). This velocity multiplied by itself (squared) and by the weight of the rim and divided by the constant 64.32 gives the foot-pounds of energy. For example, a 20-ft. flywheel with a rim weighing 30,000 lb. revolving at 80 r.p.m., or 83.7 ft. per sec., would represent $83.7 \times 83.7 \times 30{,}000 \div 64.32 = 3{,}270{,}000$ ft.-lb. of energy.

Military Road Building

By Sergt. B. C. White

I am writing this from the field to describe an engineering feat by army engineers in building a road called Vanderbilt Ave., from camp to town, requiring several bridges, cuts, fills, etc., to straighten the one time "snake road." Owing to the lack of gravel crushed stone had to be used. Not far from the road there was an old quarry of bastard granite, but the only things in the way of machinery were parts of an old belt-driven drum hoist that Noah may have used. For tools they had one ax, one timber saw, a 2-in. wood chisel and a 2-in. auger.

They investigated the scrap yards in all the near-by towns and found in one place an old locomotive-type boiler and engine mounted on wheels (35 hp.). In another place they found an old stone crusher of perhaps five yards per hour capacity; in another old quarry they found a steam drill or, rather, scraps of several out of which they contrived one that would work some, and an old pump that works well after some little tinkering up. Out of another heap of scrap they got a piece of $1\frac{15}{16}$-in. shaft and a couple of car trucks with the flanges missing on one side. They also begged a few feet of canvas belt that had been discarded in a sawmill. I think there was about 225 ft. of 8-in. belt including bad spots, which were numerous. With this accumulation assembled, they now have 200 ft. of railroad trestle made of bents with rails spiked to headframes at about a 15 per cent. grade, on which they draw stone from the quarry to the crusher. One side of the track is raised two inches higher than the other so the stone car will not jump the track on the side where the flanges are missing. They also have a belt conveyor of 8-in. belt 28-ft. centers running in a trough over 12-in. pulleys at about 100 ft. per min. This belt drops the stone into

a pocket from which the trucks are loaded. The conveyor is home-made, as it were—pipe for shafting, the bearings made of old tires when available, but many were made of wood, log ends for pulleys, etc. To make these pulleys they sawed off some pine blocks, bored a 2-in. hole through them, drove them onto the shaft projecting from the hoist and turned them to size with a 2-in. wood chisel. Some of the rails on the road are poles, and all the woodwork is of logs and poles cut in the woods. The railroad is known (locally) as the P. W. & MacD. R.R. (Pop White & MacDougal R.R.) Private Harry Cassey, who is our hard rock man, is better known as "Dynamite Cassey" in the regiment but as Captain Cassey to the natives. Little Willie O'Connors (6 ft. 3 in. tall) is a drill runner. Master Engineer Senior Grade MacDougal, who was formerly master mechanic in the subway, is in charge. The four master engineers in the group posing for their picture are, from left to right, "Pop" White, Dunagan, MacDougal and Conrow.

PREPARING STONE AT THE QUARRY FOR BUILDING A MILITARY ROAD

A Novel Method of Shipping Large Transformers

The method used by the Westinghouse Electric and Manufacturing Co. for shipping three 7500-kv.-a., water-cooled transformers from East Pittsburgh, Penn., to the Northern States Power Co., at St. Paul, Minn., is shown in Figs. 1 and 2. The weight of each transformer without oil is approximately 45,000 lb. Before placing each unit in its tank a corset of wood slats and ribs of steel was built up around it, as shown in Fig. 1, so as to give a circular shape to fit the inside of the tank. The cooling coils were left fastened to the transformer covers, and a bracing arrangement through the center of these coils against the top of the cover, which was in turn braced against the end of the car, served to hold the transformer in place inside the tank.

These transformers were so large that, even when loaded on a drop-frame car, if shipped in the upright position, they would barely be within the maximum height allowable by railroad bridges, etc., even when using special flat covers on the tanks. It was found by the engineering and construction department of the power company that if the transformers were to be shipped in this manner there would be difficulty in getting them over the streets at their destination and up a 30-ft. rise, without crushing through the streets or tipping over. They therefore suggested that the transformers be shipped lying on their sides if possible.

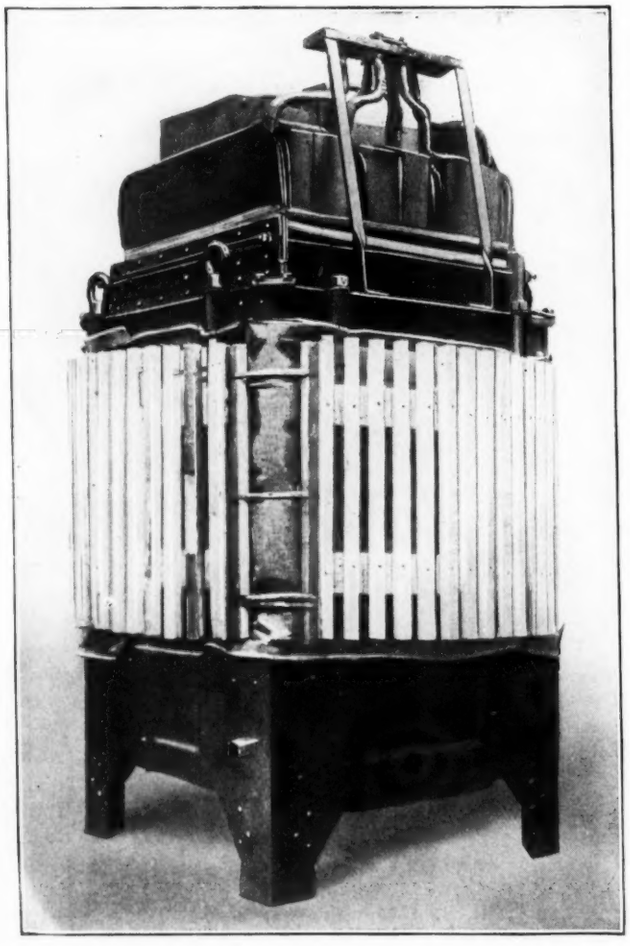


FIG. 1. TRANSFORMER READY TO PLACE IN TANK

The Westinghouse company has an ingenious cradle in which to place transformers when they are to be turned over on their sides. This cradle consists of a platform with one side projecting up at right angles to the floor of the platform. At the corner of the platform there is a rocker. Attached to the top of the side and to the outer edge of the platform are chains of equal length, which, after the transformer is placed on the platform, are attached to a crane. The crane starts lifting, and the chain attached to the platform is the one that carries the weight. This starts to tip the cradle on the rocker and when it is just half tipped, both chains are bearing the weight. As the transformer goes on over in the cradle, the chain attached to the top of the side bears the weight and the one attached to the platform is slack. By this means there is no rough jostling in tipping the transformer.

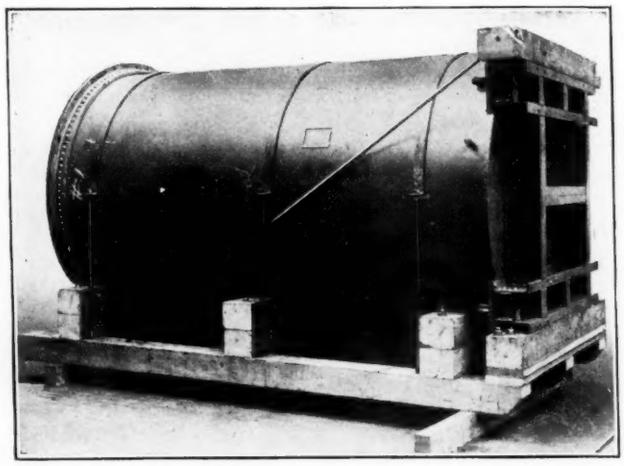


FIG. 2. TRANSFORMER IN CRADLE READY TO SHIP

A cradle arrangement, similar to the foregoing, was built for each transformer and used as a skid in shipment, and in moving the transformers over the streets and up the rise, at their destination. Fig. 2 shows one of the transformers in its cradle ready for shipping.

The transformers arrived in good condition and were skidded to position in the basement of the substation in St. Paul. Through a hole in the main floor a stationary hoist lifted the transformers out of their tanks, the packing was removed and the transformers were again lowered into the tanks and the oil put in; each unit was then lifted to the main floor and put into service.

Superheating steam increases its volume a different percentage for different pressures and temperatures. For example, steam at 100 lb. pressure when superheated 100 deg. is expanded approximately 16 per cent., while 200 deg. increases its volume 30 per cent. and 300 deg. 45 per cent. For any desired case see the steam tables giving the specific volume of saturated steam, subtract this from the specific volume for the degree of superheat and divide by the specific volume of the saturated steam; the result will be the percentage of increase in volume. The same process gives the percentage of difference in volume between two different degrees of superheat. The amount of work steam of a given pressure will do is very nearly in direct proportion to its volume. This is one of the advantages of superheating.

Troubles and Their Remedies in Gas-Engine Ignition Systems

By A. L. BRENNAN, JR.

The various troubles that may happen to either high- or low-tension ignition systems for internal-combustion engines are outlined, and how to go about locating and correcting these troubles is explained.

NEARLY all gas engines are equipped with batteries to supply the primary current to suitable coils to effect easy starting. However, in the majority of cases the magneto is relied upon to furnish the electrical pressure for constant operation. It must not be understood from this that battery ignition is not reliable, for in actual practice it is quite as dependable as that derived from a magneto.

Low-Tension and High-Tension Magnetos

Although there are many variations in the design and construction of magnetos, they can be divided into two general classes—low-tension and high-tension. In regard to the former the current is sometimes utilized direct in connection with a make-and-break igniter or is sent through a coil first and thence to the igniter. In other cases dynamos are used to supply a current for a high-tension system, the current being taken through an induction coil to obtain the necessary potential to overcome the resistance of the air gap. From this it is seen that the principal difference between low- and high-tension ignition is that a low-tension current has not sufficient voltage to break down the resistance of an air gap; therefore, in order to induce a spark, a current must be set up by a closed circuit. This closed circuit results from the movable electrode coming in contact with the stationary electrode of the igniter, which separates at a predetermined time according to the setting of the timer. As the points spring apart, the electric current has a tendency to maintain the circuit already formed, and in consequence an electric arc is formed between these two points for a sufficient length of time to ignite the compressed gas in the cylinder. One of the principal considerations involved in procuring a good spark from a low-tension igniter is to have the points in good repair and forming a complete contact; that is, their entire surfaces coming together. If two very small points only come in contact, the resultant spark will be small and may not be strong enough to ignite the gas.

The chief advantage of low-tension ignition over high-tension is absence of secondary wires and their danger to short-circuit; also, low-tension ignition is practically waterproof. It has several disadvantages, however. The timing of the break is controlled by mechanical means, and the rapidity of the rupture of current between the points is entirely dependent upon the tension of certain springs which operate under detrimental conditions, such as high temperatures. Low-tension magnetos are usually of the simple H type and have but a single coil of comparatively coarse wire. In operation the current induced in the armature fluctuates from zero to a maximum twice in each revolution, and so in order to realize high efficiency the magneto must be so timed that this maximum current will be supplied the igniter at the moment of break in the current. This is usually referred to as synchronism, meaning that the rotation of the magneto's armature and the engine crankshaft coincide in such a way that the maximum potential is utilized at the time of ignition of the compressed gas, as already mentioned. From this it is evident that a magneto of this type must be timed in such a way as to follow out the conditions cited, but this is not the case with continuous-current machines. Generators of the latter type are very easy to maintain and are surprisingly free from any complications.

The commutator should be kept bright by using fine sandpaper. The bearings should be properly lubricated, but care must be exercised against excessive oil, for it has a tendency to creep and thus destroy the insulation of the machine. The brushes should be kept clean and bear with their whole surface on the commutator.

High-tension magnetos can be divided into two classes: (1) Magnetos that merely take the place of battery and timer and deliver current to a coil where the secondary current is produced, and (2) magnetos that comprise in their construction all the elements of generating and distributing a high-tension current, which are commonly called self-contained generators, as they are only dependent upon the engine to furnish the power for their rotation, which of course must be in synchronism with the timing of the engine.

Magnetos of the latter type are subject to about all the troubles that have to do with high-tension ignition of other varieties. But as seemingly complicated as some of the troubles appear, they are in almost every instance easily traced and corrected.

Locating Faults by Elimination Method

A means of locating a fault, commonly known as the elimination method, often proves of value in quickly detecting an existing fault. For instance, suppose the engine is operating from current derived from a magneto; the first step to take is to disconnect the secondary wire from a plug and hold its terminal about an eighth of an inch from top of the latter and notice if a spark takes place. This operation is easily performed while the motor is in operation if the high-tension wires are fitted with terminals that pull off. Considering the setting of the points of a spark plug an eighth of an inch may seem excessive, but the fact should be remembered that the average magneto will produce a spark of this length under atmospheric conditions, but not in the cylinder under pressure, where the resistance offered to a spark gap is considerably more. Misfiring, although often due to faulty ignition, has other causes, such as faulty mixtures or mechanical defects that interfere with good compression.

High-tension generators are necessarily complicated to a certain degree; that is, there are several parts nec-

essary to control and distribute the current, which require more or less attention from time to time. Chief among these may be mentioned the contact points of the circuit interrupters. These points often have a tendency to wear and become pitted and thus make inferior contacts and cause misfiring. In order to overcome this defect the contact points should be cleaned with sandpaper, care being exercised to rub the surfaces flat and not wear away the edges of the contacts and thus reduce their bearing surfaces. If the pitting is very bad, the contacts will probably need filing, which will necessitate their removal. In regard to their repair, there are two conditions to bear in mind: First, to file the points to produce a smooth even surface; and second, to adjust the surfaces of the points at such an angle that when they are together their surfaces will be parallel. It sometimes happens that the points will be evenly repaired, but only make contact on their inside or outside edges. In regard to the correct distance they should be set, it will generally depend upon the make of the magneto. However, the majority of manufacturers supply suitable implements and scales for the adjustment of their machines, which should be closely adhered to. At times dust, dirt or oil will find its way into the circuit-interrupter box and cause misfiring. To overcome this trouble the interrupter box should be washed with gasoline, using a stiff brush.

To Remove Scale Deposits

Continued operation will sometimes produce scale deposits in the circuit-interrupter box, but more often on the distributor segments and brush surfaces, which is usually indicated by misfiring, but this trouble is readily remedied by cleaning the contact surfaces with gasoline.

It is very seldom that a magneto fails to generate a current. Some years ago difficulty was sometimes experienced from the failing of the magnetos owing to loss of magnetism, but this is seldom the case at present.

Any deposits on the contact surfaces of these high-tension generators will invariably interfere with uniform operation, and so they should at all times be kept entirely free from foreign substances. Oil is especially liable to creep and render a magneto inoperative. The only remedy in this case is to take the machine apart and clean it off thoroughly with gasoline. There is one thing to bear constantly in mind when employing gasoline for this purpose, and that is, do not slop it all around, allowing quantities of it to collect around the engine, for the chances are that if you start the engine soon after cleaning the magneto with this fluid, the gasoline at the contact points will ignite and start a dangerous fire. But in any case do not shut down the machine, but turn the gasoline off, if of this type of motor, so that the fuel in the carburetor will be used up in the engine instead of perhaps injuring the generator.

In order to look after a magneto in an efficient way, it must be removed from the engine. However, before this is done, suitable marks should be made that will allow the ready replacement of the magneto without changing the timing.

If a motor is equipped with both battery and magneto ignition and operates satisfactorily on the battery and coil circuit, but faulty operation follows when the magneto is switched into circuit, the trouble is in the second method of ignition, and should not be attributed to other causes. On the other hand, if misfiring occurs when either system is in circuit, it would indicate that probably some fault exists in the ignition, and it should be tested as described in the foregoing.

Particular pains should be exercised to keep all wires free from excessive chafing due to vibration, for short-circuits will result if the insulation on the wires is broken down. All terminals should be kept secure—not only the primary, but the secondary wires as well. The spark plugs should be kept free from oil or moisture, their component parts tight and points bright in order to realize the best results.

Saving by Burning Slack Coal

By F. H. Guldner

While working as a special apprentice for a Middle Western railroad, the writer was called on to determine the fuel and labor costs in a stationary power plant at one of its larger repair shops. Some rather surprising results were found, and in view of the present difficulty in obtaining, and the urgent need of conserving coal, the data showing the savings effected seem timely in again calling to attention principles well known but too often overlooked.

The table shows the amount of coal burned each month, the labor and fuel costs and, in addition, the quantity of each of the three grades of coal used—

FUEL ECONOMY EFFECTED

Month	Labor	Coal Burned in Tons: Engine	Chute Droppings	Slack	Total	Total Coal Cost
1913						
October	.....	1,115.95	28.85	.....	1,144.80	.....
November	.....	1,415.60	120.40	.....	1,536.00	.....
December	.....	1,471.90	31.35	.....	1,503.25	.....
1914						
January	$588.93	1,385.65	.....	.....	1,385.65	$2,577.31
February	584.11	1,443.80	.....	.....	1,443.80	2,671.03
March	686.24	1,629.25	31.00	.....	1,660.25	3,102.47
April	630.73	1,351.50	26.60	.....	1,378.10	2,590.83
May	613.76	877.20	42.60	55.75	975.75	1,839.97
June	596.67	895.50	.....	12.65	908.15	1,906.46
July	606.49	1,045.90	61.90	18.70	1,126.50	2,123.53
August	603.86	919.85	57.95	.....	977.80	1,825.95
September	589.83	1,041.35	.....	86.05	1,127.40	2,087.94
October	669.21	1,250.35	39.10	2.50	1,291.95	2,421.61
November	670.82	1,242.65	75.80	.....	1,318.45	2,428.56
December	723.85	1,621.35	26.40	.....	1,647.75	3,099.42
1915						
January	861.41	2,231.80	.....	.....	2,231.80	4,271.74
February	779.90	1,634.60	88.10	.....	1,722.70	3,213.61
March	700.34	1,644.45	65.75	.....	1,710.20	3,186.24
April	588.05	1,153.50	70.95	.....	1,224.45	2,280.26
May	576.29	713.95	66.95	163.55	944.45	1,621.29
June	585.37	439.25	.....	274.90	714.15	1,136.99
July	567.92	329.90	.....	385.55	715.45	1,056.44
August	587.99	85.00	.....	482.85	567.85	731.84
September	594.46	84.00	.....	477.05	561.04	692.76

engine, chute droppings and slack. In the interval given no great fluctuation in output occurred. The cost of labor for the various months was nearly uniform excepting the period from the latter half of December, 1914, up to and including March, 1915, during which time the old duplex-steam air compressor was replaced by a cross-compound two-stage compressor of high efficiency and a feed-water heater was installed. While the change was being made, air was furnished by a battery of locomotive air compressors of relatively low efficiency; this accounts for the high labor and fuel cost during these months.

In April, 1915, it was decided to change from engine coal costing about $1.85 per ton to slack at $1.10.

It was feared that it would be impossible to maintain the required steam pressure, but results dissipated this fear. About 164 tons was burned that month, and gradually the percentage of slack was increased and the amount of engine coal decreased until in August and September, 1915, the slack was nearly five-sixths of the total coal burned. About this time the writer was transferred to another position, and he was unable to get later figures. Those given, however, will be sufficient to illustrate the object of this article. By comparing the average (May to September, 1914) monthly coal cost with a corresponding period one year later, it will be noticed that it was reduced from $1956.77 to $1047.86, or 46.5 per cent. A more striking example would be to compare the average coal cost in August and September, 1914, when the old air compressor was in use and practically all the fuel was engine coal and little slack, with the same months in 1915, when the feed-water heater and the new compressor were in use and the coal conditions reversed to nearly all slack with a little engine coal. The average in 1914 for these two months was $1956.94, against $712.30 in 1915, a decrease of $1244.64, or 63.5 per cent.

This was accomplished by an investment of approximately $10,000 for the air compressor, $2000 for the feed-water heater and $6000 for removing the old compressor and installing the new equipment—a total of about $18,000—less the salvage value of the old compressor, which was sent to a smaller shop for use. No doubt there are many plants, not only in the railroad field but also in public utilities, manufacturing, etc., whose coal consumption could be materially reduced by the use of more efficient prime movers and the substitution of cheaper coal. Substitution, when possible, enables the conserving of the better coals for purposes that do not permit the use of poor coal and at the same time is profitable.

Spliced Conductors in Conduits

By B. A. Briggs

The National Board of Fire Underwriters' Rules specify that a splice in a conductor must not be pulled into a conduit. The wisdom of this ruling appears to be hard for many to appreciate. Nevertheless, that it is based on sound judgment has been proved in many cases by cable grounding on splices that have been pulled into conduits. One case in point that came to the writer's attention was that of a small rotary converter that blew one of its fuses infrequently for several months before the cause was discovered. All tests that could be made indicated nothing wrong during this period. The trouble was caused by a spliced cable, in a conduit running from the machine to the switchboard, flashing to ground at irregular intervals and each time burning itself clear without leaving any trace of the trouble except blowing the fuse. At last the conductor became grounded, and then the trouble was easily located and repaired by pulling out the old cables and replacing them with new ones.

In another case, in what is supposed to be one of the best isolated-plant installations in this country, the shunt-field winding of one of the machines of a three-wire balancing set was discovered to be dangerously hot, after the machine had been standing idle for about twelve hours. Investigation showed that one side of the shunt-field winding was connected permanently to one of the 220-volt busses and that one of the main cables running from the switchboard to the machine was grounded in such a way as to leave the shunt-field winding connected across the 220-volt circuit.

In this plant the cables from the switchboard pass down through bushings in the floor into a large $\frac{3}{16}$-in. iron duct, about 6 in. deep by 2 ft. wide, which runs the entire length of the switchboard. From this duct the cables run in conduit to the various circuits and machines. It was in this duct that the ground was located on the cable. The cable, like a lot more of them in this duct, had been cut too short and was spliced

CONDITION OF SPLICE AFTER BURNOUT

out to reach up to the terminals on the back of switchboard. In making the splice, points of solder were left, or maybe some of the ends of the wire were not properly forced down into the splice, so that in time, because of the vibration of the cable against the bottom of the duct, the insulation was broken down and a ground occurred. Some severe arcing must have taken place, since, as the illustration shows, considerable of the splice is burned away; also a large hole was burned into the $\frac{3}{16}$-in. iron-duct wall. This splice from all appearances had been thoroughly insulated by both rubber and friction tape, and could not have been subjected to any of the abuses that it would receive if pulled into a conduit; nevertheless, it failed as many other cable splices have failed in conduits. Consequently, there is but one safe rule: Obey one of the mandates of the National Electrical Code and do not pull spliced conductors into conduits.

Burning Oil or Tar in Combination With Coal

The coal shortage has caused most engineers to consider using whatever fuels are available whether they be the various grades of coal, fuel oil, tar or bagasse, and to provide an auxiliary fuel should their coal give out. Dr. W. N. Best has lately brought forth an invention which makes possible the quick change from coal to oil or tar and vice versa. The usual location of an oil burner is at the ashpit or the fire-door. This invention leaves these doors free for use without disturbing the burner or the piping. It is sold by W. N. Best, Inc., 11 Broadway, New York City.

Referring to Fig. 1, it will be observed that the liquid-fuel burner is mounted on the side or front wall of the boiler furnace. Fig. 1 shows that the burner is in the operating position. Fig. 2 shows it in the idle

position as it would be when no liquid fuel at all is being burned or when fuel on the grate only is burning. Notice that by moving the operating lever to the up position, the sliding gate closes the opening in the side wall so that no air is admitted here while the liquid-fuel burner is idle. It will be observed, also, that should it be desired to operate at rather low boiler capacity, the sliding gate may be operated so as to admit a little air, or rather so as to admit the quantity of air required by the amount of fuel being fed. Greater capacity may be had by opening the sliding gate more and more and feeding greater quantities of oil and steam for atomization.

Readers will, perhaps, remember that an oil burner of similar design is in general use. With the old-style burner equipment designed by Dr. Best no provisions other than a few loose brick were made for closing up the openings in the side or front wall when the burner was not in use. This, of course, means that great quantities of excess air are admitted to the furnace when the oil burner is not being operated. With the new device the opening is closed tight when the burner is idle and is adjustable to accommodate various capacity demands. The apparatus lends itself to the use of auxiliary fuel.

Manifestly, no alterations are required to the boiler or the furnace to attach the burner. If liquid fuel is burned, the grate may be covered with ashes for protection.

The burner is one wherein the oil, tar or liquid-fuel opening or outlet is at right angles to the direction of the steam outlet; that is, the steam used for atomization. This steam sweeps directly over the oil or liquid-fuel outlet, thus keeping the outlet free of the carbon so frequently found on burner tips.

Where tar is burned, the fuel may gravitate to the burner from a tank mounted on top of the boiler or in an elevated and warm location in the boiler room. Heating coils are provided so that the fuel may be heated nearly to the point of vaporization.

One burner is used per furnace regardless of how large or how small the furnace may be. This is true for oil or tar. The atomized oil issues from the burner through a diverging groove in the burner tip. The flame is flat and, depending upon the shape of the groove, is long or short.

The oil or liquid-fuel control valve is provided with stops which may be set by the boiler-room engineer after he determines the limit of open position of the valve, thus preventing the fireman from exceeding this limit.

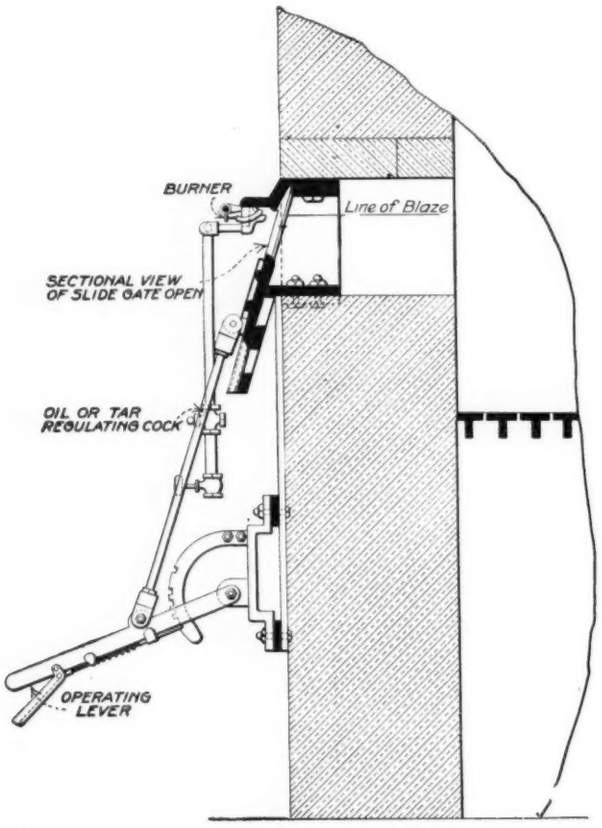


Fig. 1

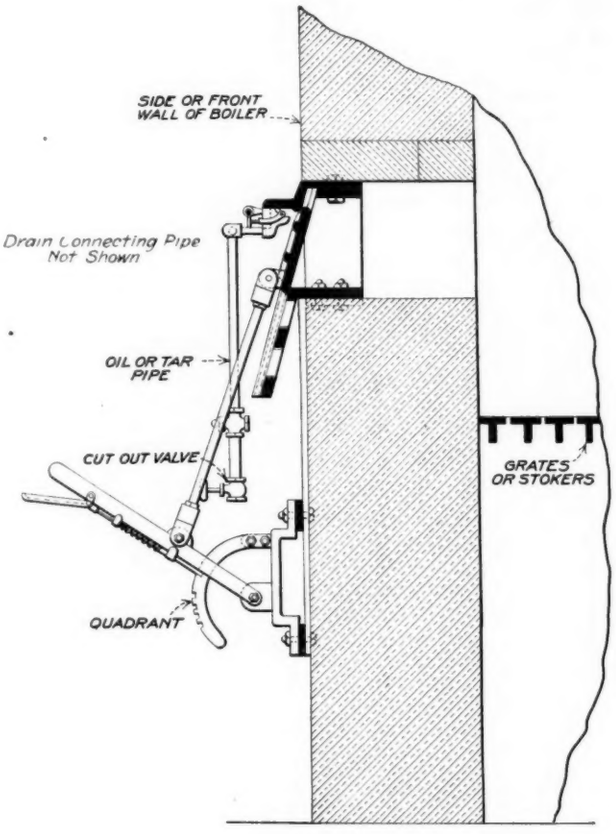


Fig. 2

LIQUID-FUEL BURNING APPARATUS FOR USE IN COMBINATION WITH COAL

Fig. 1—Burner in Position for Use. Fig. 2—Burner Shut Off and Opening in Furnace Wall Closed

A Handy Packing Cutter

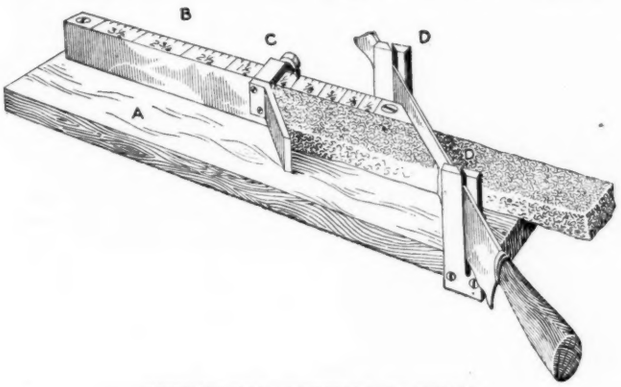
By J. A. Lucas

Many methods of cutting piston-rod packing have been published in *Power*, but I have never seen anything similar to the tool shown herewith.

The base *A* is made of wood 1 in. thick, 3½ in. wide and 21 in. long. The gage bar *B* is about 16 in. long and is made of hardwood. One end is cut to an angle of 45 deg. The sliding block *C* is part of an old motor

brush-holder with a piece of $\frac{1}{16}$-in. iron bent to an angle of 45 deg. riveted to it. The bar *B* is made an easy sliding fit for the block, which is clamped to it by the thumb-screw placed on the back side. The knife guides *D* are made of $\frac{3}{16}$ x 3-in. iron and are about 4 in. high, with the slot cut on an angle of 45 deg. and set so that the knife will just clear the end of the bar *B*. A common bread knife with scalloped edge is used for cutting the packing. The top of the bar *B* is graduated so that the distance from the knife to the stop, when set at a certain number, gives the length of the circumference of a circle of that diameter, plus $\frac{3}{16}$ in. for expansion.

To lay off the graduations on the bar, get a table of circumferences of circles, and to the length of the circumference add $\frac{3}{16}$ in. for expansion up to 2 in. diameter; $\frac{1}{4}$ in. from 2 to 3 in. diameter, and $\frac{3}{8}$ in. for larger diameters. After measuring off their distances on the bar, stamp them with small figures or other suitable



DEVICE FOR CUTTING PACKING

marks. The distance from the knife to the 2-in. mark by this method is 6½ in.; to the 2½-in. mark, 8 in., etc.

To operate, first get the diameter of the rod, which is, say, 2 in. Add the size of the packing, which in this case is, say, ½ in., amounting to 2½ in. This is the diameter of a circle passing through the center of the packing ring. Set the gage at the 2½ mark on the bar, and cut the first end at an angle in the slot; then butt the packing against the stop *C* and cut off. This would be the length for a good fit, with the right amount of room left for expansion.

Vibration Effects on the Operation of Electric Generators

By R. K. Long

Vibration may be due to causes internal or external to a machine, or both, the result being cumulative or otherwise. The commoner causes of vibration are unbalanced rotors, bent shafts, improper foundations and fastenings, excessive speed, excessive and fluctuating loads, vibration of the structure housing the machine, its periodicity of vibration being superposed upon that of the machine. Some machines show less vibration with no load than with load. Others again vibrate only when running light or at a definite load, still others only with load changes. The effects of vibration upon direct-current machines is probably more serious than on alternating-current.

Vibration in direct-current machines may cause loose connections and open-circuits. Abrasion also often occurs, the effect of which causes short-circuits and ground in the windings. Brushes may chatter, causing sparking, poor commutation and rapid deterioration of the commutator and brushes, with accompanying higher cost of upkeep, as well as interfering with the capacity and regulation of the machine. With certain classes of brushes increased heating, due to sparking and unequal current distribution, causes the lubricant to exude from them, gumming the commutator and permitting carbon dust to collect, causing flashovers and making the brushes stick in the holders.

A bent shaft in setting up vibration also causes unequal air gaps as it revolves, which may result in overheating the equalizer rings or taps in some form of armature winding. Bad commutation results in any case; flat and burnt spots may appear at definite spacings around the commutation. A bent shaft may damage the insulation or cause breaking of armature conductors; unequal wear of bearings may occur, due to shaft out of alignment. Throwing lubricating oil may occur, which may soon eat into the mica of the commutators, doing serious damage, for oil is the arch enemy of mica.

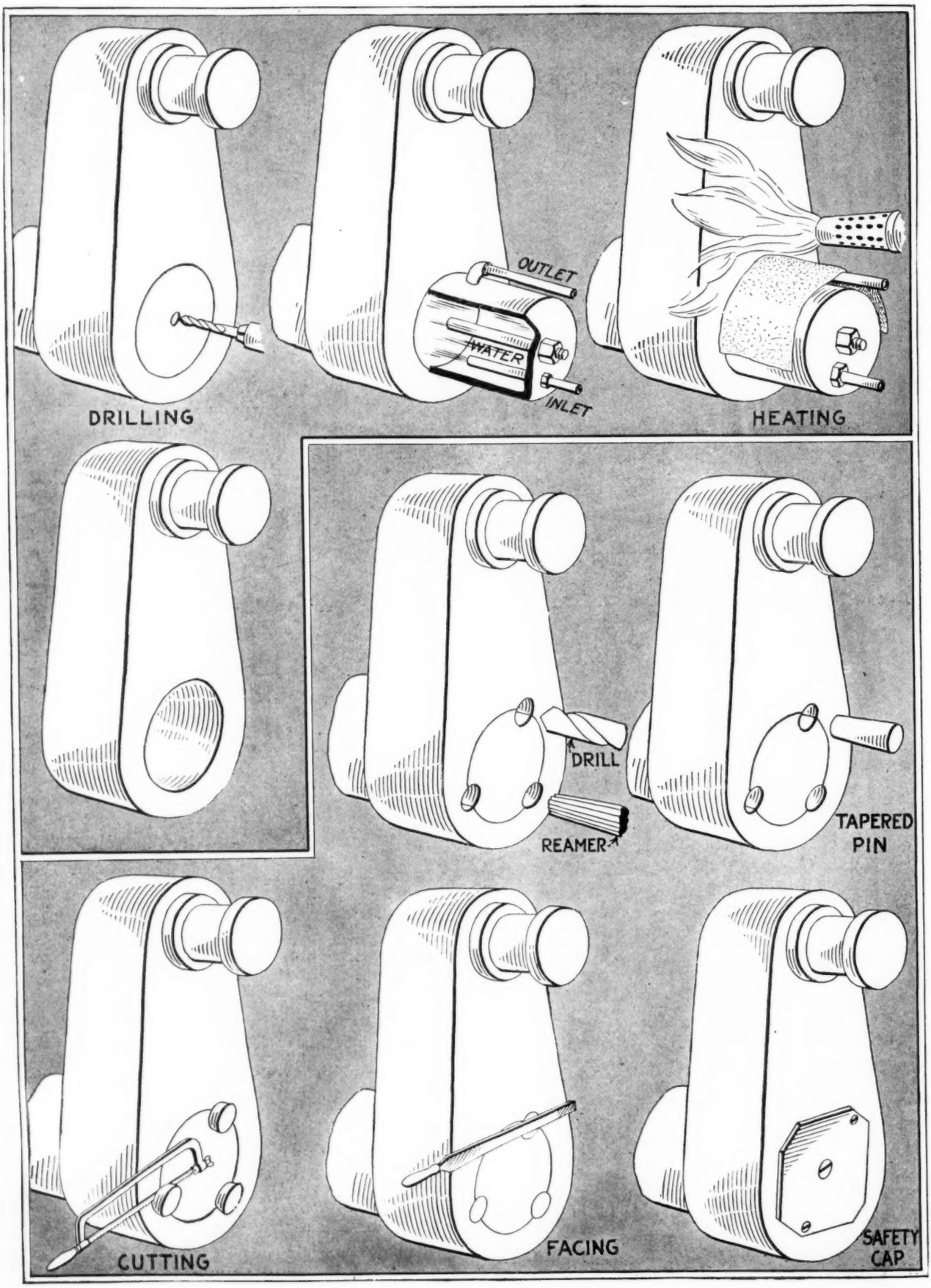
Alternating-current generators are usually less influenced by vibration than direct-current machines, owing to the absence of the commutator. Where the units have a direct-connected exciter, however, they may suffer in the same way as the direct-current generators already referred to. Excessive vibration has often resulted in grounding and short-circuiting of the field winding of high-speed turbo-generator units, the result of which is that the field current is increased, causing overheating and finally failure, by burning out the entire field winding.

The stator, or armature, of alternators also suffers from vibration. Conductors work loose, enabling them to move with load changes, causing deterioration of the insulation and failure under normal potential. Another result of vibration sometimes encountered in large turbo-generators is that the emergency steam valve closes accidentally, shifting the generators' load to other machines—a somewhat serious matter where the load may be 20,000 kv.-a. or more. Vibration is perhaps more likely to occur in the rotating elements of steam-turbine units than in other types, because of the accumulation of scale. This is, however, a transitory condition.

In one case a machine was installed upon a girder so that it wabbled from one side to the other with load changes, a matter easily remedied by leveling the machine and grouting, at the same time solving a difficult commutation problem. Several boosters have run away with varying degrees of damage on account of broken field coils, due to vibration. Bent shafts have added their quota to strange voltage drops for no apparent reason, although brushes sticking in the holders may have helped in this case.

There are many degrees of vibration, causing as many effects, some obvious and others not so apparent. All unnecessary causes should be eliminated because vibration is always objectionable, since it shortens the life of materials, wastes energy in the form of noise and needless motion, which lowers the efficiency of the apparatus and increases the difficulties and cost of operation. Provided a machine is properly designed, installed and maintained, most of the troubles enumerated may be prevented, and prevention is always better than cure.

Illustrated Crank Job



Editorials

The Coal Supply and the Railroads

WITH the extraordinary demand for fuel consequent upon the war the price of coal went to exorbitant figures. A contract was no protection, for the contractor simply avowed his inability to carry out his agreement, and those who had to have coal—and that means everybody who bought it, for nobody buys coal for bric-a-brac—had to go out in the market and outbid the others for it. The consequence was that notwithstanding the alleged inability of contractors, handlers and dealers to get coal, there was more coal than ever mined and sold, but at greatly increased prices.

And then the people spoke up and said, through their President: "This profiteering must stop. We will pay you producers so much per ton for the coal at the mine. The railroad haulage is fixed. You jobbers and retailers can have so much per ton"; and it looked as though the consumer was going to get his coal for cost plus a more or less fair profit.

But notwithstanding the price allowed per ton at the mine was away above what they had got before the war, the producers, or some of them, averred that they could not produce at that price; and the long-suffering people raised the price still higher with an intimation that if the producers could not and did not produce at that price, they would take over the mines and do it themselves.

And then it was found that the greater part of the coal had been already sold on contract at prices above those fixed by the Government; and again the long-suffering people, standing abashed before the sanctity of contract and the horror of upsetting business, said: "All right, we will pay these prices that somebody has contracted for us, for their payment will come upon us in the final analysis, but only on the contract coal. Let the free coal come along at the prices we have fixed."

But the price did not go down. The cost for railroad haulage was controllable, but there was a shortage of bottoms and of tugs, and prices for water transportation went soaring. When one must have coal or shut down and another has coal and wants to turn it into the most money that one's necessity will compel him to pay, it takes more than a Government dictum without penalties for its evasion to keep them apart. A bet that the Washington Monument will fall in two weeks; an intimation on the part of the coal merchant of his willingness to part with a treasured desk weight, a bull pup, an old white horse or some similar object of virtu upon sufficient inducement, offers an opportunity for the purchaser to pay the difference between the price at which the Government has said the dealer must sell and that which is fixed by the buyer's necessity and the dealer's cupidity. Speculators offered to furnish coal if they were permitted to bill at the Government price and collect at their own. Contracts were dated back to precede the Government order. Wagon mines sold coal at the Government price, but on condition that they be allowed to haul it; and made up in the haulage charge the extortion which the President's order was intended to inhibit.

And still the prices do not go down; the free coal does not come along and the shortage has increased until factories are shut down, ships lie in the harbors with empty bunkers, while the goods that they should transport glut the terminals and clog the railroads. War work is hampered, public utilities are crippled, hotels are without light and heat, and long lines of shivering men, women and children stand waiting for hours for the privilege of buying a pailful of coal at ten dollars a ton. The death rate from pneumonia in New York has gone up enormously.

Whose is the fault and what is to be done about it? The anthracite producers say they cannot produce on account of labor shortage, and they send, to a market which is in a condition where it must take anything, the ejecta of more exigent years, burdening the already overloaded transportation system with tons of worthless dirt and slate and ash sold at the price of good coal. Trainloads of this coal, large and small, good and bad, were held almost within sight of New York until shifting engines could pull out of the maze cars bearing particular numbers consigned to the particular man whose barge was ready, because, they say, some ridiculous Government regulation decreed it so. The Administration has now decreed that the coal shall be pooled and kept moving.

The bituminous producers claim that they can mine, with the plant and labor available, more coal than the railroads can furnish cars to take away and that they are filling cars as fast as they get them. The mine is the best storage for the coal until it can be shipped. The railroads say that they have cars enough, but that their systems are blocked by priority orders, excessive demands upon their equipment and lack of motive power.

It would take 5000 locomotives to replace those worn out in the United States every year. In the month of October there was ordered in the whole country just *one*. In the last five years the number ordered per year has been on an average 2391 and has never exceeded 3467; and just previous to the war the shops of the American Locomotive Company were almost shut down for lack of orders. With a mild winter and an ordinary amount of traffic the railroads might have pulled through again. A season of exceptional severity and the extraordinary traffic due to the war have swamped them. If the Government had been operating the railways and had gotten them into this self-confessed condition of impotency, Government ownership would have been indicted as long as the memory of it should last.

It is useless to inquire how we drifted into this con-

dition, except as the inquiry may help us to avoid doing it again. The thing now is to get to running again. The combining of the railroads into a consistent unit under Government control, with the resources of the entire country back of them, was the logical first step, and if the railroad managements with whom the operation of the roads is still left will concentrate on getting the most that is possible out of them under the new coöperative conditions instead of worrying about when they are going to get them back or trying to discredit Government operation, the task will be easier. In the meantime let us not blame the Government if it cannot make a run-down cripple do a giant's task.

Developing the Water Powers

THE most insistent of the conservationists in and out of the Government have always been ready to permit private capital to develop the water powers upon terms which would insure the complete return of the investment with interest and a fair profit upon the business done, subject only to such risk as attends the development of any water power outside of Government control. After years of hampering argument and struggle between those who sought to obtain the control of the water powers and those solicitous for the rights of the people, the Administration has prepared a bill which, in view of a public sentiment created by months of vigorous propaganda by chambers of commerce, industrial committees and similar organizations, is likely to pass. This bill, while an improvement on former measures, does not appear to us to be without objection.

Any bill, while guarding absolutely the safety of the investment against confiscation or embarrassment by Government interference, should provide for the retaking of the privilege by the Government when the people need it or conditions make it advisable. This bill gives an irrevocable grant for fifty years, at the end of which time the Government "shall have the right" to take the property, not by paying back what the investor put into it, less what he has paid himself back besides his fair profit, but by paying "the fair value not to exceed actual cost of the property taken." Inasmuch as the fifty-year grant is insisted upon in order that the bonds may be retired out of earnings within the life of the grant, this would appear to allow the investor to recover his investment out of earnings, and then collect it again when the plant is sold.

A "fair value" is indefinite and indeterminable. The price of recapture should be fixed at actual investment less depreciation. Depreciation is simply retired investment and should be deducted from the capital account, leaving the amount upon which interest is allowed and which must be paid upon recapture.

"The United States shall have the right" to take the plant over. Who is going to exercise this right or determine that it shall be exercised—the President, the Congress, the Commission, or who? Unless the provocation is great, there will be no concerted movement on the part of the consumers, and a Congressman would have to be a radical spoiling for a fight to undertake the recapture on his own initiative.

We should like to see the bill stipulate that current should be sold at cost plus a fair (and stipulated) profit. This involves an oversight of the issue of securities and of expenditures to insure that all the investment incurred appears in the property in either material or service, and is essential also to establishing the recapture value. The Commission established by the bill is empowered to prescribe rules for uniform accounting, to examine books and to require full statements as to cost of operation and the production, transmission and sale of power, to hold hearings in connection with the regulation of rates or service; but the Commission has no rate-making power except for interstate business or in states where no such regulation exists. The delegation of such powers to state public-utilities commissions is not likely to be so positive and satisfactory as a specification of the allowable rate of profit and the methods of its determination in the grant.

Wherever licenses to states or municipalities are mentioned, it is prescribed that the power is to be generated solely for state or municipal purposes. Does this preclude the obtaining of a grant by a state or municipality for the purpose of generating power for the use of its inhabitants?

Altogether, the bill is a great improvement upon former attempts, but we should like to see it more specific and positive in the particulars mentioned.

Government Control of Fuel Oil

THE President's fuel-oil proclamation of February fourth, which went into effect the following Monday, or the eleventh, now gives the Government control of the transportation and distribution of the two chief fuels. Considering the troubles that producers, shippers and consumers of fuel oil have been having, it is assumable that they welcome the Government's action.

Take New England, for example. Oil displaces about one million tons of coal per year at the present consumption. It is used in many industries vital to the prosecution of the war. The shippers of the oil and the consumers have viewed with no small measure of alarm the commandeering of oil-carrying ships by the Government. One company transporting great quantities of oil to New England ports has six ships left out of a total of twenty-one, the Government having taken the difference. Much of this oil goes to Providence by water and then by rail inland to the points of consumption. The serious congestion of the railroads has caused excruciating delays of tank cars both going and coming. Lately, one car was six weeks from Providence to Lawrence, Massachusetts, and return. There is not an abundance of oil-tank cars even for normal conditions of demand and transportation. Now fuel oil will likely have a priority commensurate with its value as a war essential.

The situation had become serious for New England, and the President's proclamation is by no means premature. To cite another case: A consumer of fuel oil in Boston has been compelled to transport oil for his plant by motor truck from Providence to Boston because the shipper could not get oil beyond Providence. The truck or trucks had to be kept going night and day. The expense is obvious. Doubtless one of the first moves of Mark L. Requa, new head of the Oil Division, Fuel Administration, will be the elimination of condi-

tions that impose such hardship upon the shipper and consumer.

The priority list for deliveries of fuel oil as announced from Washington are, in the order of preference, as follows: Railroads and bunker fuel; export deliveries or shipments for the United States Army or Navy; export shipments for the navies and other war purposes of the Allies; hospitals where oil is now being used as fuel; public utilities and domestic consumers now using fuel oil (including gas oil); shipyards engaged in Government work; navy yards; arsenals; plants engaged in manufacture, production and storage of food products; army and navy cantonments where oil is now used as fuel; industrial consumers engaged in the manufacture of munitions and other articles under Government orders; all other classes.

Plants not making munitions or other articles under Government orders are therefore twelfth on the list. The order of preference appears eminently fair. If the head of the Oil Division gets the right kind of coöperation from Mr. McAdoo and if the Navy Department and Shipping Board will not divert more ships from our coastwise oil trade than extraordinary emergencies demand, Mr. Requa will be free to devote his time to moving oil instead of needing all time available to care for complaints, as the state and local fuel administrators have to do.

Why Not Have an Ash Inspector?

TODAY we have fire inspectors to see to it that the means used for generating, transmitting and utilizing power are not allowed to become a fire hazard and endanger the safety of the community. We have boiler inspectors, in some cases backed up by the law of the state, whose business it is to have all boilers maintained in such condition that they will not become a menace to life and property. We also have fuel administrators, both national, state and municipal, whose good purpose it is to control the destiny of the nation's coal pile. All this may be very commendable, but how about what happens to the coal after it goes into the boiler room?

An inspection of the contents of the ash cans on the curb waiting to be removed from in front of many of our large buildings would indicate that many plants have coal to throw away. The time when we can afford to allow coal to be used in such a way that a large percentage of its carbon content is thrown away in the ashes has long gone by. Although the fuel supply will last for hundreds of years hence, nevertheless it has been the bitter experience of millions in this country and abroad recently that it is almost impossible to obtain fuel at any price. Landlords, using the coal famine as a pretext, have allowed their tenants to suffer for the wanted heat, and some of the traction companies have tried heating their cars with animal heat, while the public paid for something they did not get. Yet, after all we have been experiencing from a coal shortage, it is difficult by inspection to tell whether the contents of many of the ash cans waiting removal from in front of a number of our city buildings are intended for coal or ashes.

If the owner of a plant, whether it be for power or for heating purposes, is willing to allow a large percentage of the coal thrown into the boiler furnace to be carted away in the ashes when the nation is facing a coal famine like the present, it is time that some pressure be brought to bear from the outside by someone who has the power to have the conditions remedied or to cut off the offending ones' coal supply. One of the ways to get at this would be to enact a law limiting the carbon content of the ashes from boiler furnaces to a certain percentage and to appoint inspectors to investigate the ashes coming from every plant and see to it that the law is being complied with.

As long as the manner in which a power plant was operated did not in any way seriously affect the community, how it was run was very largely nobody's business but the owners; but when it has come to the time when it means that coal wasted in these plants is coal that somebody else seriously in need of it must go without, then it becomes the public's business how even a private plant is run. Many of the central stations throughout the country have been forced to curtail their output for certain illuminating purposes, consequently suffering a loss of revenue, in order to save coal for private industries and heating. In justice to these public utilities which have had their output restricted by Government control to conserve the nation's fuel supply, the same Government should see to it that the fuel used in private plants is utilized in the most economical way and not thrown out in the ashes.

That the electrical interests have been alive to the opportunities afforded by the exceptional fuel situation is evidenced by the general advice given by fuel administrators to power users to conserve fuel by patronizing the central station. The advice is honestly and disinterestedly given, but the shutting down of many an isolated plant would mean a waste rather than a saving. Many power users who would otherwise have put in or continued their own plants have been driven to adopt "street service" by the uncertainty of the fuel supply or the impossibility of getting deliveries on apparatus. On the other hand, many owners of plants depending upon central-station current and idle for the want of it are hustling for steam, gas and oil engines.

Now or never Rhode Island coal has its chance. There is said to be a large quantity of it above ground as the result of Henry M. Whitney's attempt to develop the mines some years ago. The coal is hard, almost graphitic, but will burn, and might be used to advantage mixed with bituminous. It was of these mines that William Cullen Bryant wrote,

> That men might to their inner caves retire
> And there, unsinged, abide the day of fire.

An expressive statement of the purpose of the American Association of Engineers, emanating from its secretary, is that it is to put scientific management behind the young engineer and get him into the place where he belongs in a nation organized for over-all efficiency.

At the Kansas State Agricultural College there are one hundred and fifty women studying electrical engineering. Many women are employed in the central stations of Europe. Welcome to our ranks.

Correspondence

Losing Water from a Heating Boiler

The attendant of a small heating plant had considerable trouble in keeping water in the 60-in. diameter boiler over night, and although it was filled nearly full it was necessary to put in considerable city water each morning before starting up. On one occasion it was impossible to get any heat in the system at all until it was drained, as it was full of water.

At one time some radiator repairs had been made and the steam fitter had, as a matter of safety, closed the stop valve on the return pipe and the attendant had closed the stop valve over the boiler. When the attendant opened the stop valve on the top of the boiler, he forgot to open the valve on the return pipe, and the condensed steam filled the heating system full of water, as it could not return to the boiler. When the stop valve on the return pipe was opened the boiler filled and some of the water had to be blown out through the blowoff. This freed the heating system, but the next morning the water was again out of sight in the gage-glass and considerable water had to be supplied.

It was noticed that there was water in the ashpit, and it was supposed that it seeped through the ground. Investigation showed water trickling out through the brickwork just below the grates on the water-column side. The boiler was shut down, the brickwork was torn away, and just back of the water column the bottom connection from the front head to the water column was found badly corroded externally; and although the brickwork was dry at this time, it evidently had been wet during the summer months while the boiler was out of service, as it was customary in the spring to play the hose over the top of the boiler brickwork to settle the dust before brushing it down. Probably because of this considerable moisture remained in the side walls and caused corrosion at the pipe connection. After repairs were made, the boiler gave no more trouble for several days, when the water again disappeared from the boiler and the radiators and pipes began to hammer furiously.

Investigation showed that the attendant had closed the stop valve on the top of the boiler while making a radiator repair, and he either forgot to close the stop valve on the return line or else depended on the check valve to hold the water in the boiler. But the check valve was out of order and allowed the water in the boiler to back up in the return pipes to the radiators, thus causing the water-hammer. Opening the stop valve on the top of the boiler equalized the pressure, and the boiler quickly filled up. Luckily, there was but little fire in the furnace or the fusible plug would have been melted.

The check-valve disk was found to be disconnected from the hinge plate, the nut holding it being missing; one side of the bolt end was also broken off. Someone had slotted the end of this bolt on the back of the valve disk and, after putting on the nut, had driven a blunt chisel into the slot to spread the end of the bolt and thus prevent the nut from working off, but in doing so had fractured the metal on one side, which had eventually come out, leaving the nut loose, which also dropped off and then the disk dropped from the hinge.

It is always best to close the stop valve on the return pipe before closing the stop valve on the steam line, but do not forget to open it. If it is forgotten, however, the water will not escape from the boiler very rapidly by evaporation and it will be noticed at the water glass before the water becomes too low.

In one instance the floor in front of the boiler was covered with several inches of water one morning. The blowoff pipe passed beneath the floor of the next room, which was about 30 in. higher than the floor in the front of the boiler. The blowoff-valve stem had been leaking, corrosion had eaten the pipe through, and water escaped from the boiler overnight.

Where pipes go through a brick wall, they should pass through a sleeve of a larger diameter, and underground blowoff pipes should not be buried, but should be surrounded by a box to keep the earth moisture from the pipes to prevent corrosion. R. A. CULTRA.

Cambridge, Mass.

[These experiences of a man who evidently did not know his business emphasize the need of a license law to protect such men and others against their own ignorance. The owner of the plant evidently hired an inexperienced man because he was cheap, and at the same time ran a very favorable risk of ruining the boiler by burning and the piping system by water-hammer, to say nothing of a possible boiler explosion.—Editor.]

Inadequate Provision for Expansion

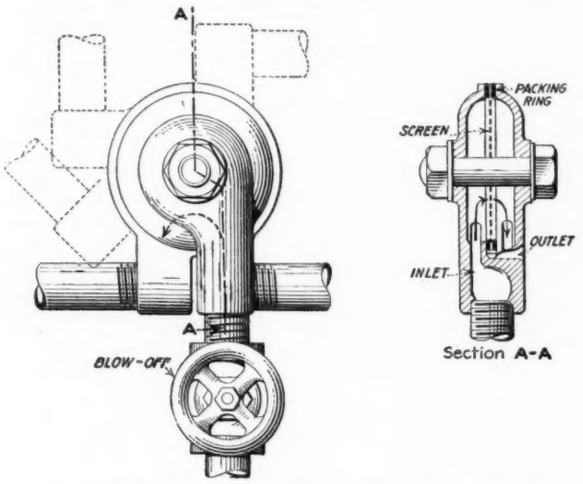
A practical demonstration of the necessity of allowing liberally for the expansion of a pipe line to carry steam came under my observation several years ago. The 2-in. pipe line was intended for use in emergencies, to serve a tank pump when the boilers were off in that part of the plant. About 400 ft. was laid under ground, ending with a tee to make the turn into the building and a nipple and valve for a bleeder, in a shallow wooden box about 2 ft. square.

When steam was turned on slowly, the engineer went down the line to close the bleeder, but he found the pipe had lengthened and pushed the valve and nipple through the side of the box, so the only thing to do was to shut off and wait for the line to contract enough to take the nipple out and screw a plug into the tee and do the draining at a point beyond. All the expansion had gone one way because of the considerable pitch downward in that direction. J. LEWIS.

New York City.

Strainer for Pipe Lines

Attention is frequently called to the necessity of connecting strainers to the inlet piping of steam traps and other such apparatus, and considerable trouble is caused at times by dirt getting into them. This led



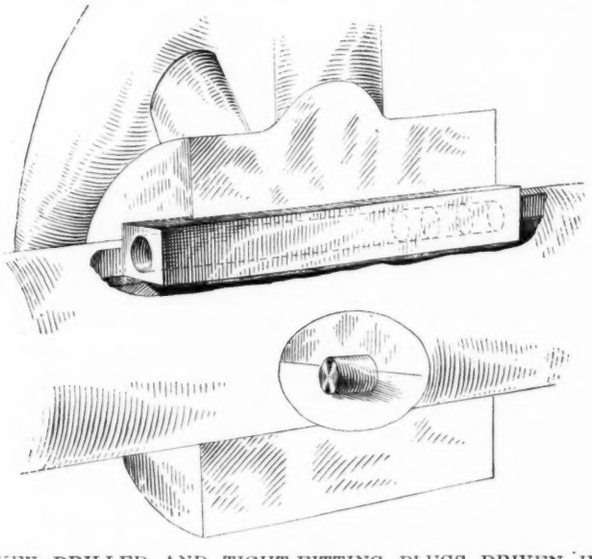
NOVEL TYPE OF STRAINER TO GO IN PIPE LINE

me to design a strainer in accordance with my own ideas, as shown in the illustration. It can be put in a line in place of a union or a pipe fitting, can be used to form any desired angle and is extremely simple.

Hasbrouck Heights, N. J. GEORGE J. LITTLE.

"Buttoning a Key"

This is a means of tightening a key in its keyway when it is difficult to remove it, as in some cases it means dismantling a lot of parts to take a key out. Drill the key lengthwise, being sure not to cut through



KEY DRILLED AND TIGHT-FITTING PLUGS DRIVEN IN

the sides of it, then cut off pieces of round steel about half an inch long and a little larger than the hole and drive them in separately until they fill the hole solid. When the job is done, you have as tight a key as you ever had. GEORGE H. DIMAN.

Lawrence, Mass.

Three Motors Heated

The connections for two single-phase transformers when operated open-delta from a three-phase circuit are shown in Fig. 1. The voltages of the secondary side are displaced 120 deg. from each other and are of the same value, therefore any three-phase device that is operated from the secondary will, under normal conditions, be subjected to balanced three-phase voltages.

A construction contractor complained that three three-phase motors which he had just started on a new job heated so badly when operated for only five minutes without any connected load, that it was impossible to use them. He further stated that their operation had been entirely satisfactory on the preceding job.

The fact that all the motors heated in this case, whereas none had ever heated before, suggested trouble in the 220-volt service line. As there was no voltmeter available, the voltage at the motors was roughly meas-

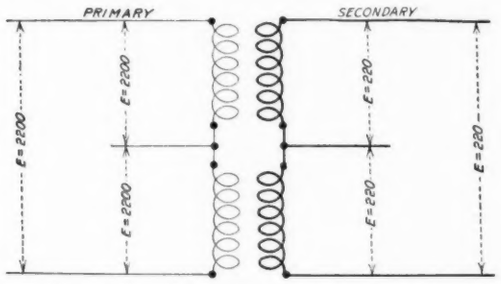


FIG. 1

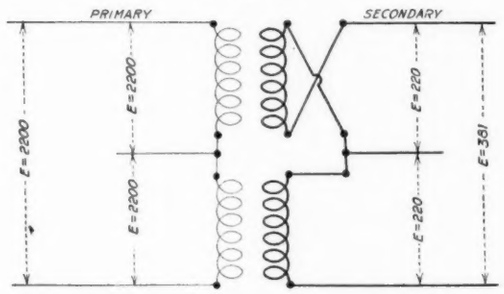


FIG. 2

FIGS. 1 AND 2. DIAGRAMS OF TWO TRANSFORMERS CONNECTED OPEN-DELTA

ured by means of two 110-volt lamps connected in series. From the middle to either outside wire the voltage appeared to be about normal, but between the two outside wires the voltage was abnormally high. It was determined that in using supply transformers that were made by different manufacturers, the two secondaries had been connected with the wrong polarity, as indicated in Fig. 2. Reversing the polarity of one transformer not only increases the value of the voltage between the outside legs 1.732 times over that of one phase, or in this case $220 \times 1.732 = 381$ volts, but also changes the phase displacement between the resultant voltage across the two transformers and that of each unit from 120 deg. to only 30 deg. As a result of the error, not only was one phase winding of all motors subjected to 73 per cent. overvoltage, but the torque characteristics were so much modified that the rotors, even when free, would not come up to full speed. E. C. PARHAM.

Brooklyn, N. Y.

Ideal Power-Plant Location

Mr. Dow. in his article on "Production of Electricity by Steam Power," in *Power* of Dec. 11, speaks of the location of power plants, and this brings to my mind the ideal location of a small country plant. Of course they wanted to get as near the center of distribution as possible, and in looking for such a site found a creek running through this section. They decided that by making a reservoir near a railroad they would be sure of water and also be accessible to a coal supply. After excavating a few feet, solid rock was found, which was blasted out and considerable of it used in the construction of the plant.

So here we had an ideal location, with plenty of water, and in making the reservoir we secured enough stone to build the plant, which was erected within one hundred feet of the main-line railroad, with the plant located in about the center of distribution.

New York City. D. R. HIBBS.

Lamp Bank as a Rheostat

In connection with electrical work there are innumerable instances where some form of rheostat is required for reducing the current in a constant-potential circuit. There are many forms and types of rheostats, using metallic or carbon resistance units or a liquid; but they may all be classed under one of two categories, those for continuous service and those for intermittent service. Rheostats used in charging storage batteries or in motor circuits for speed control must be designed for continuous service; rheostats used for starting duty only need be designed for intermittent service.

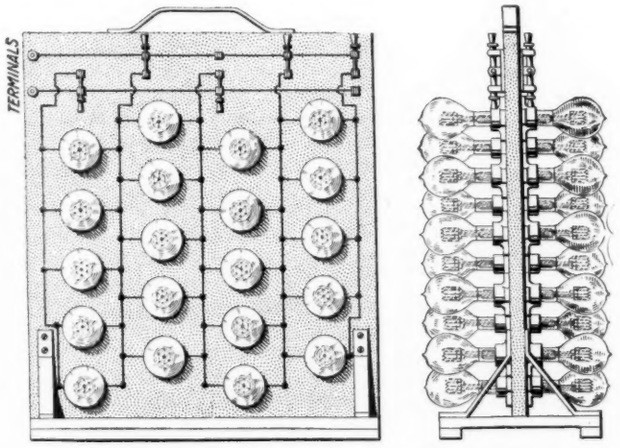
The ordinary electric lamp offers a convenient means of designing a rheostat for continuous duties, which is easily made from material readily obtainable almost anywhere.

The figure shows a rheostat that is made up of 110-volt lamps arranged so that they may be used on 110, 220 and 440 volts. The shape and size of such a rheostat depend upon where it is to be used. For use around a power station or an industrial plant, lightness and portability are important features. For this purpose a ¾-in. wood board treated with asphaltum paint or, better yet, a piece of asbestos board, or slate if the rheostat is for stationary purposes, may be used. At one end of this board are placed five 5-amp. single-pole knife switches, two of them double-throw and three single-throw, mounted on porcelain bases, which should be left on, since the porcelain insulates the live parts of the switch from the wood. These switches are mounted as shown in the figure, with the lamp sockets in four rows, where five switches are used. The number of lamps per row depends upon the desired capacity of the rheostat and the permissible length. The lamp sockets may be mounted on about 4½-in. centers.

From the figure is obtained an idea of the wiring scheme, an arrangement that permits closing switches, counting from the right-hand side, Nos. 1, 3 and 5 down and 2 and 4 up for 110-volt service; Nos. 1 and 5 down and 3 up for 220-volt use; thereby connecting two rows of lamps in series; likewise for 440-volt service, four rows of lamps would be connected in series by closing No. 1 down and No. 5 up.

A single-throw double-pole switch may be installed at the top of the board to permit the opening and closing of the rheostat without interfering with the position of the smaller switches. If portable, a handle should be mounted on the top of the board to carry the rheostat from place to place. This handle may be a hole of suitable shape cut in the board.

If the rheostat is equipped with a base so that it will stand in an upright position, both sides of the board can be used for the mounting of lamps and switches as shown in the figure. Installing lamps and switches on both sides of the board makes the rheostat twice the former capacity. If so desired, metal guards may be placed on the board to prevent the lamps from being broken. This device may be filled with any size lamps that the spacing will permit and from one to forty lamps may be cut in at will; also, four lamps can be connected in series. Therefore, it is readily seen that the individual resistance may be varied over a wide range. Where the lamps are to be connected



FRONT AND SIDE VIEW OF LAMP RHEOSTAT

in series, care must be taken to see that they are all of the same size.

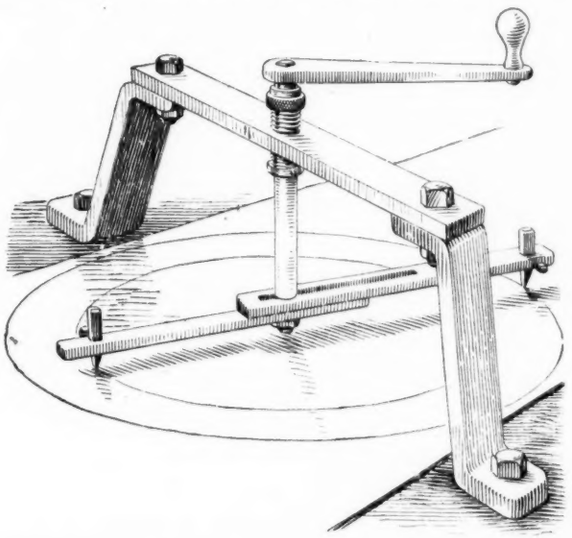
The uses to which a rheostat of the foregoing type may be put around every power house and industrial plant are almost endless. It may be used for meter checking, for testing small machines or for drying out new or damp equipment by current control, or as a heater; also for charging small storage batteries. It can be placed in the armature or shunt-field circuit of motors to vary their speed, although in the latter case care must be exercised that the field is not accidentally opened or the motor may run away and destroy itself.

It permits apparatus designed for a given voltage to be operated at a higher, by absorbing the excess voltage in the rheostat, this being accomplished by connecting a voltmeter across the terminals of the current-consuming apparatus, which is connected in series with the lamp bank. The rheostat is then manipulated until the voltage indicated by the voltmeter connected across the device is of the desired value. Another use for the rheostat is as a light cluster, and I have used it as such on several occasions to good advantage. In fact, it will be found a useful and frequently used adjunct to ary electrical equipment.

Chicago, Ill. M. A. WALKER.

An Easily Made Gasket Cutter

Having wasted considerable packing by hacking it out on the flange with a ball-peen hammer, I made a gasket cutter of the design shown in the illustration.



GASKET CUTTER MOUNTED ON A BENCH OR BOARD

The cutter bars are adjustable to suit a large range of sizes. Considering the large number of gaskets used to keep things tight, such a device is worth while.

Concord, N. H. CHARLES H. WILLEY.

Synchronoscope Needle Stuck

Paralleling a rotary converter with another machine of the same type is generally an easy job, but one morning a machine in the substation where I was working, caused considerable disturbance. The machine had been brought up to the correct speed, and we were watching the synchronoscope so as to close the oil switch at the right moment. Finally the hand revolved very slowly, indicating about synchronous speed and then suddenly swung to the zero position and stayed there. The operator waited for an instant and then closed the switch. There was a succession of flashes from the commutators of the machines, accompanied by bangs and flashes as the reverse-current relays operated and tripped out the circuit-breakers on the direct-current side. The machines began to slow down, indicating that the transmission line from the main station had opened.

The end cells of the storage battery were cut in to hold up the voltage until the machines could again be started. One of the rotaries was cut in on the starting circuit before it stopped and was brought up to speed again ready to be connected in on the alternating-current circuit as soon as the transmission line was made alive.

When the synchronizing plugs were put in again, the hand on the synchronoscope still remained at the zero position. Evidently, something was wrong with the instrument since a pair of lamps, which were also connected to indicate synchronism, were fluctuating properly; these were used as an indicator and the machines put in service. When the synchronoscope was opened, a piece of insulation was found jammed between the rotating member and the poles of the instrument, which must have happened as the needle came to zero position.

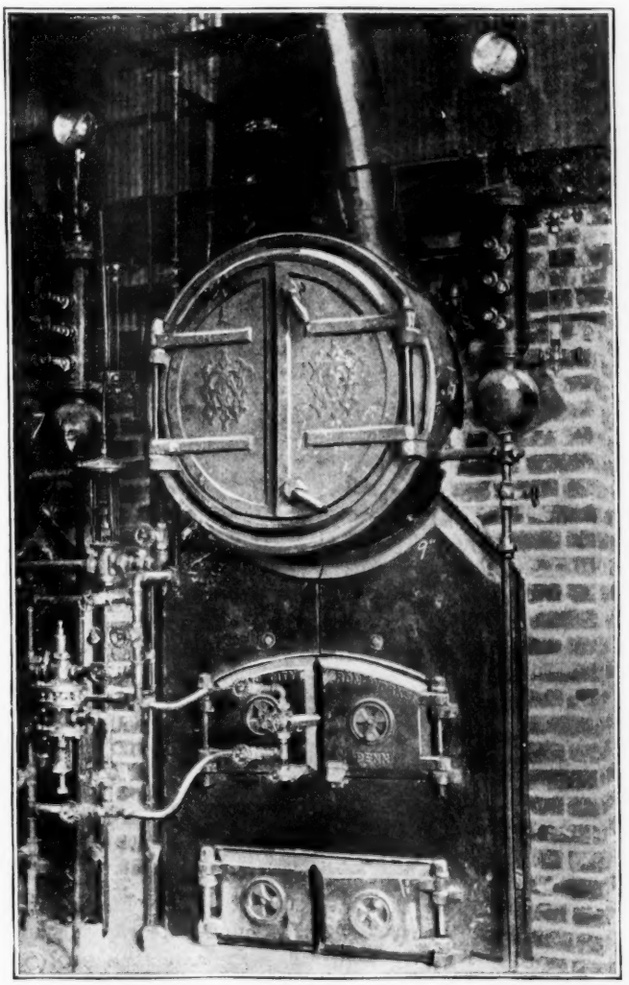
If the operator had watched the lamps as well as the indicator, he would have noticed that something was wrong and would not have closed the switch until the trouble had been investigated; which we all received strict orders to do after the experience related.

Minneapolis, Minn. E. W. MILLER.

Unusual Equipment on Small Boilers

The complaint in most small power plants is the absence of devices that render the operation less of a care. In striking contrast the photograph shows some of the equipment on a pair of 36-in. by 10-ft. return tubular boilers (normal rating 20 hp.) that have been rather overburdened.

These boilers furnish steam to the oil burners of a number of kilns and, as shown, are provided with feed-water regulators, automatic stop and check valves on the 2½-in. steam nozzles and automatic regulators for the oil burners; also damper regulators are about to be installed. One thing that catches the eye, however, is that



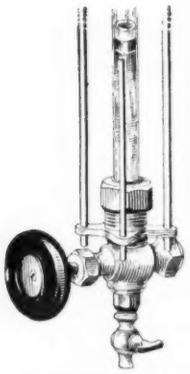
OIL BURNER AND FEED-WATER REGULATORS

the water columns are several sizes too large. The lower gage-cock is correctly located, but the upper one is about level with the top of the boiler.

Kansas City, Mo. C. O. SANDSTROM.

Water-Level Indicator in Gage-Glass

It is sometimes hard to see just where the water is in gage-glasses on the fronts of boilers, heaters, etc., that have become fogged and dirty. The trouble can be obviated by placing a hollow cork in the glass, as shown in the illustration, as the cork can be readily seen and being hollow and a loose fit in the glass, will not affect the level of the water. This, of course, is not a new or original "stunt," but is simply a reminder or suggestion to someone who has not thought of it. There have been numerous floats, to go into gage-glasses on the market in years past, but the cork will serve the purpose just as well and costs nothing. Giving the cork a color, red for example, that will make it more clearly visible is also advantageous in extreme cases, but is not often necessary.



CORK IN GAGE GLASS

New York City. D. R. HIBBS.

Priming Centrifugal Pumps

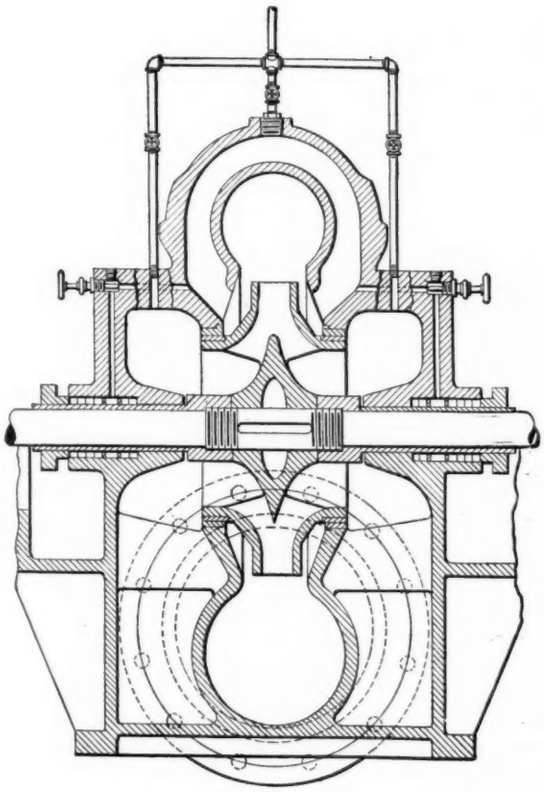
All high-grade centrifugal pumps are equipped with wearing rings, the duty of which is to act as packing and prevent the liquid in the pump from flowing back to the suction chamber. Therefore they must be a close running fit and have sufficient surface to prevent excessive leakage. The best pumps are equipped with double wearing rings which can be easily replaced when wear occurs. If such a pump is run without water even for a short period, there is great danger of these rings heating and scoring. Pumps have sometimes been run without water until the rings, usually made of brass, have become hot and seized and have either broken or stopped the pump; in fact, there is danger of wrecking the pump, especially a new one, when this happens. For the foregoing reasons no centrifugal pump should be run until the operator is sure that it is primed.

A centrifugal pump cannot handle air alone and for that reason is not self-priming, and air must be prevented from entering it while in operation, or its capacity will be reduced to a marked degree or the flow of water may stop entirely. The shaft is often provided with water seals or lantern glands. In operation these glands are filled with water, under some pressure, which prevents air leaking into the pump through the packing and also lubricates the packing, preventing any heating or scoring of the shaft. Some engineers have used grease successfully in these lantern glands and prefer it to water.

A centrifugal pump can be primed in a number of ways. If the water flows to the pump under a suction head, the only thing required is to open the suction valve and the vent at the top of the pump until all air is expelled, and the pump is then ready to run. If operating against a suction lift, it will be necessary to get the air out of the suction line and pump casing before it will be possible to begin pumping water. If there is a check or foot valve in the suction line, water can be run back down the discharge line against this foot valve, allowing the air to escape at the top of the pump casing. If there is no check or foot valve, the pump can be primed by exhausting the air from the pump and pipe with a water, steam or air ejector. In this case the discharge valve must be closed to prevent air coming in from the discharge line. Connect the ejector to the top of the pump casing and draw off all air; start the pump with the discharge valve closed, and when the pump is up to speed, open the discharge valve gradually and the pump will promptly go into service.

A permanent vacuum connection can be used to advantage when operating a centrifugal pump on a high suction lift. Vacuum connections should be made to all closed chambers or spaces not in open communication with the main vent opening, as shown, and when starting a pump all valves should be open; but when the pump is in operation, the valves should be open just enough so that any air coming in with or being released by the liquid will be drawn off by the vacuum. When a pump is so connected, a small amount of water is apt to be drawn over into the vacuum, but this can be controlled by the regulating valves or by running the pipe high enough above the pump to prevent any water flowing to the vacuum. If the latter method is used, it will be necessary to connect an enlarged section of the pipe in the line in order to separate the air and water and break up the air-lift action. It is possible to operate pumps provided with vacuum connections at practically full capacity on a suction lift of 27 in. of mercury with the temperature of the liquid from 70 to 80 deg. F. H. L. THOMPSON.

St. Louis, Mo.



VACUUM CONNECTIONS FOR PRIMING CENTRIFUGAL PUMP

Inquiries of General Interest

Heat Value of Coke—What is the heat value of coke? H. M.

The heat value of coke depends mainly upon the percentage of ash, which varies from 5 to 20 per cent. With theoretically perfect combustion a pound of average coke yields about 12,000 B.t.u.

Advantages of Cylinder Counterbores—What is the advantage of counterbores in the ends of steam-engine cylinders? E. L. B.

The principal advantage is to allow the piston to override the ends of the main bore and thus prevent the wear by the piston from leaving a shoulder in the main bore at each end of the stroke. Counterbores also are advantageous in requiring less length of reboring and in affording convenient means for determining the original centering of a cylinder.

Setting Boilers in Battery at Different Levels—When boilers of different sizes are set in the same battery, what advantages, if any, are to be obtained by placing them so their water lines will be at the same level? W. R. P.

The boilers will have different rates of evaporation, and to maintain proper water levels when in operation, each will require special adjustment of its feed valve. Hence no advantage is to be obtained by having a uniform level of the water lines, excepting for filling the boilers when cold by regulation of a single water-supply valve.

Soft Bearing Metal of Lead and Antimony—We wish to use a quantity of soft bearing metal and are thinking of making a mixture of 80 parts of lead to 20 parts of antimony. Would this be good proportions? F. F. B.

The high crystalline structure of antimony is likely to cause it to separate and become "rubbed out" of an alloy of lead and antimony if the proportion of antimony is higher than 17 per cent. of antimony to 83 per cent. of lead. "Carbox" metal is made in the proportions of about 15 per cent. antimony and 85 per cent. lead.

Use of Motor Below Rated Capacity—We have a 250-hp. three-phase induction motor that is used for driving a centrifugal pump requiring 170 hp. input to the motor. Is there enough loss in efficiency on account of the motor being underloaded to warrant installation of a smaller motor? A. H.

The efficiency of standard types of electric motors of 250-hp. capacity, when in good working order, ranges from 92 to 94 per cent., and the efficiency of the motor when operated at 170-hp. would be practically the same. The efficiency of the present motor is probably quite as high as might be expected of a 170-hp. motor of the same type, and a change on ground of superior efficiency would not be warranted.

Adiabatic Compression of Ammonia—What is the formula that expresses the relation of pressure to volume in adiabatic compression of ammonia? C. W.

The equation for adiabatic compression of ammonia gas is

$$p_1 = p\left(\frac{v}{v_1}\right)^{1.32}$$

where v = the volume at the initial absolute pressure p, and v_1 = the volume at the absolute pressure p_1. This formula signifies that the ratio of the volumes is to be raised to the 1.32 power and the.. multiplied by the initial pressure for obtaining the final pressure, or pressure obtained for an intermediate volume v_1. For compression to 0.9 of the initial volume, the equation becomes $p_1 = p\left(\frac{10}{9}\right)^{1.32} = p \times 1.149$; for 0.8, $p_1 = p \times 1.342$; for 0.7, $p_1 = p \times 1.601$; for 0.6, $p_1 = p \times 1.962$; for 0.5, $p_1 = p \times 2.496$; for 0.4, $p_1 = p \times 3.352$; for 0.3, $p_1 = p \times 4.900$; and for 0.2, $p_1 = p \times 8.368$.

Advantage of Spiral Form of Crank Arm—What benefit is derived from having a spiral form of crank arm such as sometimes used for transmitting foot power to lathes and to spindles of grinders? B. R.

The spiral form of crank arm is beneficial only when, from its flexibility, it permits of smoother conversion of reciprocating to rotary motion, or when appropriately designed, the flexibility causes the force applied to the crankpin to throw it off the dead-center, in which there may be advantage for starting off the stroke, but no less energy is required to overcome resistance that may be offered to complete revolution of the crankshaft. Various other forms of flexible mechanism have been proposed for the crank motion of reciprocating engines with the erroneous idea that they effected a saving of power, though some have been successfully employed for permitting the engine to start up from any point of stroke of the piston.

Relation of Piston Clearance to Cylinder Clearance—How is the percentage of clearance of a compressor determined, knowing the distance of the piston from the cylinder when the compressor is on a dead-center? C. W.

"Distance of the piston from the head of the cylinder" is understood to signify what is commonly termed "piston clearance," or distance the piston would have to be moved beyond the end of its stroke to place it in contact with the cylinder head. Cylinder clearance is the volume of the space in the end of the cylinder and connected passages and spaces when the valves are closed and the piston is at the end of the working stroke. The cylinder-clearance volume can be found by filling the clearance space with water and determining the volume of water required. Cylinder-clearance volume usually is expressed as a percentage of the volume displaced by one stroke of the piston: hence the percentage would be 100 × volume of cylinder clearance ÷ volume displaced by 1 working stroke of the piston.

The cylinder clearance for any assumed piston clearance will be the cylinder clearance for 0 piston clearance plus the piston displacement due to a stroke that is equal to the assumed piston clearance.

Factor of Evaporation Generating Superheated Steam—What would be the factor of evaporation under the following conditions: Steam generated at 168 lb. boiler pressure; temperature of steam, 394.5 deg. F.; feed water, 143 deg. F.? G. A. E

The formula for factor of evaporation is

$$F = \frac{H - h}{970.4}$$

where F = factor of evaporation, H = total heat of 1 lb. of the steam, h = heat of 1 lb. of the feed water, and 970.4 = the latent heat of evaporation at atmospheric pressure, or number of B.t.u. required to evaporate 1 lb. of water from 212 deg. F. into steam at atmospheric pressure.

Dry saturated steam at 168 lb. boiler pressure, or 168 + 15 = 183 lb. per sq.in. absolute, has a temperature of 374.5 deg. F. and if the temperature is 394.5 deg. F. there would be 20 deg. of superheat. According to Marks and Davis' Steam Tables of properties of superheated steam, the value of H in the formula, for the total heat of 1 lb. of the steam, would be 1209.7 B.t.u. above 32 deg. F., and as the value of h for the heat per pound of the feed water would be 143 — 32 = 111 B.t.u. above 32 deg. F., by substituting these values in the formula, it becomes $F = \frac{1209.7 - 111}{970.4}$, or factor of evaporation = 1.1322.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Absorption Refrigerating Machines*

By F. C. SPANGLER†

Fully describes the absorption machine, high- and low-pressure, and tells how to operate and care for them. Causes of lack of capacity, making a charge of ammonia, purging the system, thawing the freezer coils, care of the ammonia-pump regulator, cleaning coils, locating slight leaks.

A SECTIONAL view of the Carbondale exhaust-steam refrigerating machine is shown in Fig. 1, and briefly described, the method of operation is as follows: The generator is filled with sufficient aqua ammonia to cover the steam coils, and the absorber with enough to submerge the water tubes. The brine pump is started and brine is circulated through the cooler coils. Then the water is turned into the machine. The inlet water enters the bottom header of the condenser and, after it passes through the condenser, enters the absorber. It circulates through the tubes of the absorber; thence through the weak-liquor cooler, and finally into the rectifier. By this arrangement the water is used four times, each stage being at a somewhat higher temperature than the preceding. Thus the water consumption of the machine is greatly economized.

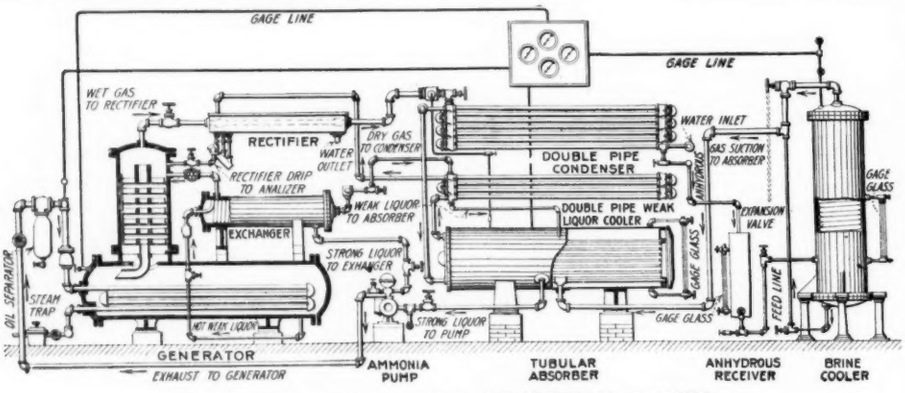


FIG. 1. TUBULAR TYPE ABSORPTION SYSTEM

Steam is now gradually turned into the generator coils until the full exhaust-steam pressure is reached. As the steam heats the ammonia in the generator, the "generator" pressure, which indicates the pressure in the generator, condenser and rectifier, will rise until it reaches a point sufficiently high to condense the ammonia gas in the condenser.

As the gas passes through the rectifier on its way to the condenser, the cool water circulating through the tubes of the rectifier chills the gas sufficiently to separate any entrained moisture that may be contained in it. The dry, or anhydrous, gas passes to the condenser, where it is condensed and falls in liquid form into the anhydrous receiver. The liquid anhydrous ammonia thus formed is then allowed to pass through the expansion valve into the brine cooler, the same as in the compression system. The expansion valve is throttled so as to keep a constant liquid level in the anhydrous receiver.

The pressure in the brine cooler is much below that of the condenser, and this drop in pressure causes the ammonia on entering the cooler to boil and absorb the heat from the brine in the coils. This changes it from liquid form on entering the cooler into a gaseous state on leaving it. The method of condensing the ammonia gas and the refrigeration that is produced in the brine cooler are identical with the compression system.

The problem now is to recover this gas. To do this, the weak ammonia liquor, which was left behind in the generator, and from which the gas has been expelled by the heat in the steam coils, is drawn from the bottom of the generator, through the exchanger, and thence through the weak liquor cooler into the absorber. Owing to the great affinity of water for ammonia gas, this weak ammonia liquor absorbs the gas in the absorber as it comes from the brine cooler, and by this means keeps down the pressure in the cooler. In turn, this weak liquor becomes enriched or strengthened by the ammonia gas and forms a strong liquor. This strong liquor is drawn from the bottom of the absorber by the ammonia pump, which discharges it into the exchanger, where it circulates around the coils that contain the weak liquor and then passes into the generator. The exchanger is simply a heat exchanger and answers the same purpose as a feed-water heater in a steam boiler plant. It heats the strong liquor on its way to the generator and cools the weak liquor.

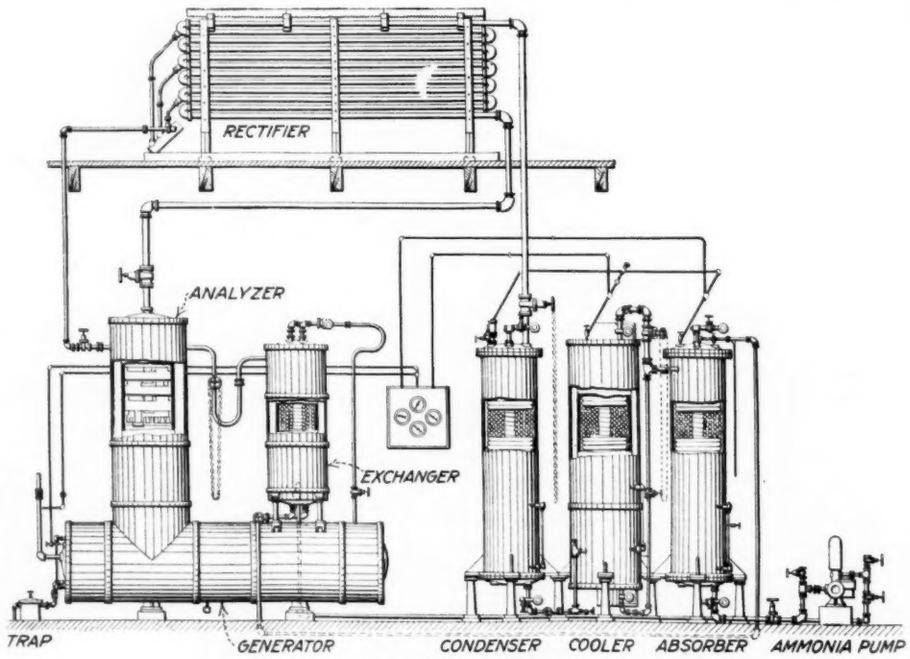


FIG. 2. SHELL TYPE ABSORPTION SYSTEM

*From a paper before the New York Engineers' Protective Association, November, 1917.

†Engineer, the Carbondale Machine Co., 50 Church St., New York City.

We now have the strong liquor back in the generator, ready for redistillation, and the cycle is complete.

The Carbondale Machine Co. builds three types of ice and refrigerating machines—the shell, atmospheric and tubular types. The original Carbondale construction was of the shell and coil type, shown in Fig. 2. This machine was the development of the old Pontifex design, which was brought to this country in 1884 and has been gradually improved until it has produced high efficiency. This type of machine is admirably suited for condensing water that is free from dirt and incrusting solids.

A number of these machines have been in operation for over twenty years without any coil renewals or repairs, and are giving good service today. The generator used with all three types is of the same construction and is provided with return bend coils of extra-heavy pipe. The condenser, exchanger and absorber of the shell type have cast-iron or steel shells, supplied with spiral wound coils of suitable proportion for the work contemplated.

In case of warm or muddy water the atmospheric type of machine shown in Fig. 3 is recommended. In this machine the exchanger is of either the double pipe or shell type, the latter construction being shown. In case the water is sea water or at all corrosive, I would recommend the use of extra-heavy galvanized pipe in the rectifier, weak-liquor cooler, condenser and absorber; but in case it is of high temperature, such as comes from a water tower, full-weight ammonia pipe will answer the purpose and, if properly painted, will last for years. The rectifier is placed under the weak-liquor cooler, so that the cooling water is used by this cooler before it descends to the rectifier. The condenser is placed above the absorber, so that the water passing over it runs down over the absorber, and by this means the quantity of condensing water is economized. With the majority of atmospheric absorption machines, the condenser and absorber are located side by side and the water is used independently over each part of the apparatus, thereby increasing the consumption. The absorbers ar provided with an injector arrangement.

Though a helical-coil cooler is shown, this construction can be used with expansion coils in the ice tank or with a horizontal-tubular cooler, if preferred.

The tubular type of machine, Fig. 4, is the latest development of the Carbondale construction, and consists of a generator similar in construction to the preceding types, a double-pipe rectifier, double-pipe exchanger, weak-liquor cooler and condenser and a tubular absorber. This is particularly adapted for low headroom and is easily accessible for repairs. Furthermore, containing nothing but straight pipes, it can be readily inspected and cleaned. In cases where the condensing water is corrosive, the use of galvanized tubes is recommended.

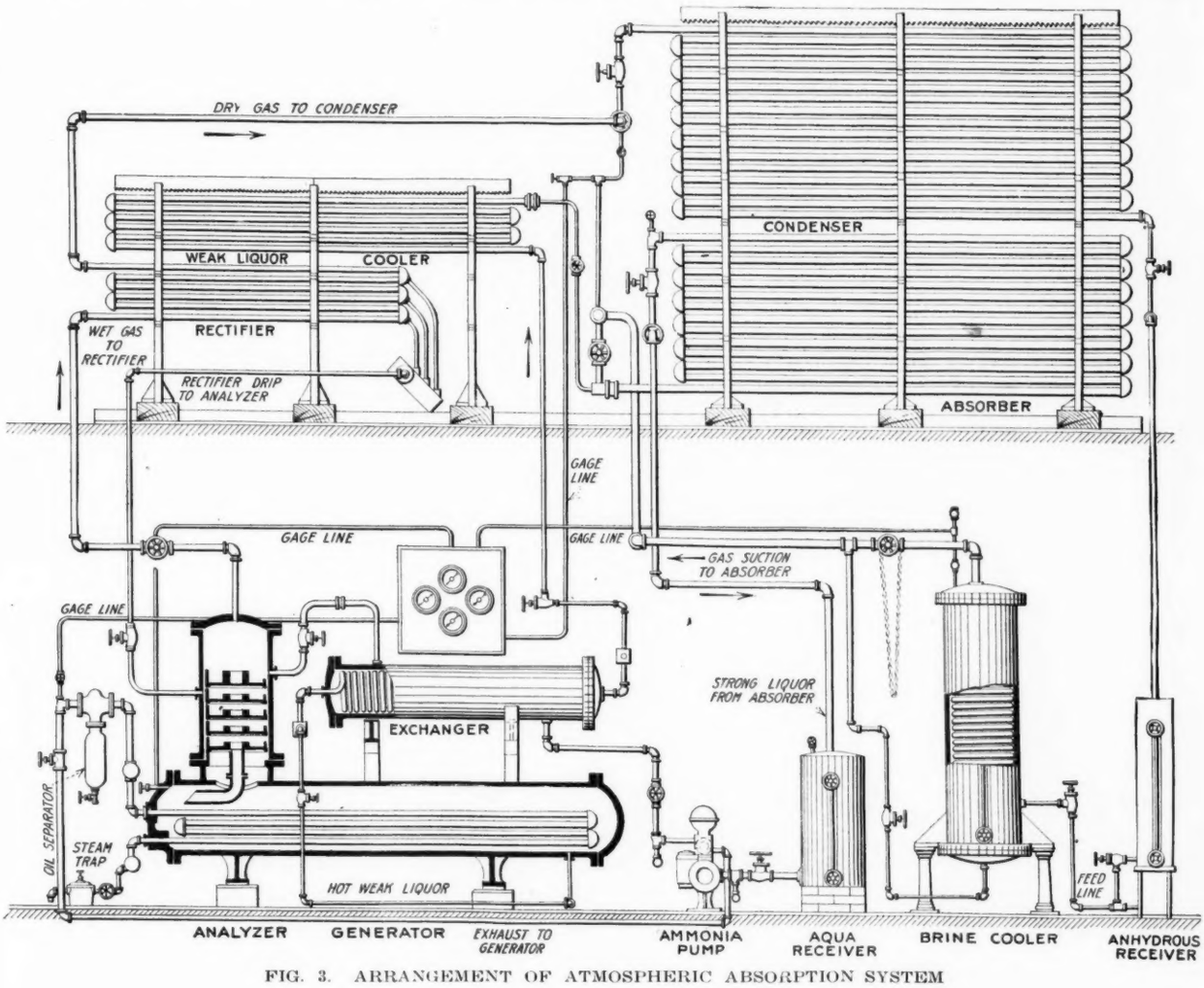


FIG. 3. ARRANGEMENT OF ATMOSPHERIC ABSORPTION SYSTEM

Special attention is called to the water connections. To economize, the water first enters the bottom header of the condenser, the overflow passing to the absorber. From there it passes to the weak-liquor cooler and thence to the rectifier. By this means the water is used through all four parts of the apparatus progressively and consequently the quantity of water is no greater than that required with a compression machine.

The advantages of the absorption system are: (1) It takes very little steam at 30 lb. per hour per ton refrigeration effect; (2) if exhaust steam or waste heat is available it takes no live steam except that required to run the small ammonia pump; (3) it has no heavy moving parts and cannot be materially damaged by carelessness; (4) it

has no oil to clog and insulate the pipes; (5) it does not require heavy foundations, can be placed on the top floor of a building and makes no noise or vibration; (6) it can easily and economically produce low temperatures.

Operating and General Information

To start the machine, assuming that the machine has a normal charge, proceed as follows: (1) Start water circulating through machine; (2) start brine pump, making sure that the brine is circulating through cooler; (3) turn steam gradually on the generator (this steam should never be entirely shut off); (4) open the gas line between the cooler and the absorber; (5) open the weak liquor valve setting it as in usual running; (6) start the ammonia pump; (7) when the generator pressure is raised to about that usually carried, slowly open the valve between the rectifier and condenser; (8) open the expansion valve and set it. The machine now is in regular operation.

To stop machine: (1) Shut off steam on the generator, leaving a little turned on; (2) shut the expansion valve; (3) shut down the ammonia pump; (4) close the weak liquor valve; (5) close the cooler and absorber gas line valve; (6) close the valve between the rectifier and condenser; (7) shut down brine pump; (8) shut off water supply.

The causes of lack of capacity are: (1) Insufficient water supply; (2) insufficient brine supply; (3) insufficient ammonia charge; (4) air or foul gas in the machine; (5) dirty condenser, absorber and rectifier coils; (6) cooler in need of purging.

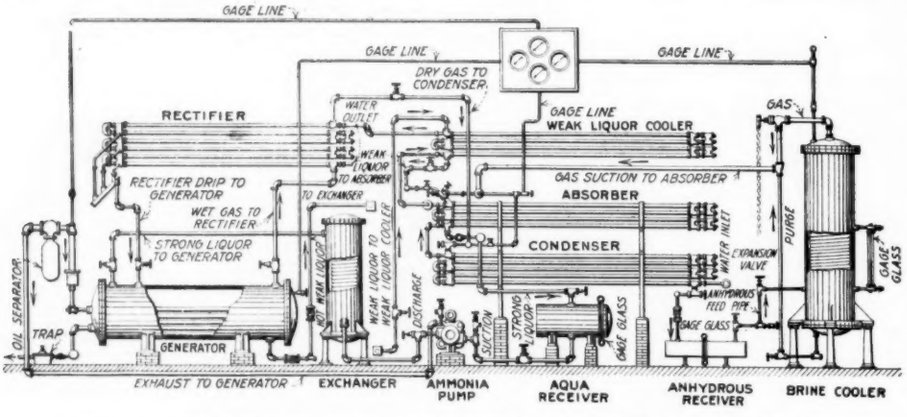


FIG. 4. DOUBLE-PIPE TYPE ABSORPTION REFRIGERATING MACHINE

Steam pressures: In case of the exhaust machine the steam pressure is usually in the neighborhood of three pounds, and does not vary. In case of the standard machine the steam pressure should be regulated according to the water temperature. Ordinarily, the steam pressure should never be in excess of one-third of the generator pressure. For example, with 150-lb. generator pressure, 50-lb. pressure on the generator is the maximum. If the machine is properly charged to do full capacity, a higher steam pressure will tend to dissociate the ammonia gas. Make sure that the generator steam coils are clear of condensation. An air-cock is provided on the bottom header for the purpose of relieving air from the coils and also indicating whether any condensation backs up in the coils. At times traps do not work properly, and it is always well to keep this air-cock open slightly to indicate any accumulation of condensation. When the machine is shut down, except for a long period, a little steam should always be allowed to enter the generator, so as to keep the shell warm.

Ammonia charge: With the machine in regular operation, and a normal charge, the following will be the conditions as indicated by the gage-cocks on the various shells. The generator will have 1 to 2 in. of liquor covering the coils. The absorber will have 1 in. of liquor covering the tubes or, if a shell type or atmospheric machine, it will have about 6 in. of liquor in the shell or receiver. The condenser will have 4 to 6 in. of anhydrous in sight, and the brine cooler will have enough anhydrous in it to frost over both gage-cocks and show a flush of soapy fluid in the glass when the cocks are opened. The gas line should be slightly frosted back to the absorber. This, however, should never frost sufficiently to show frost on the purge line.

Water supply to machine should be as regular as possible and a branch should be taken off the main at a point where other connections would not interfere with the flow to the machine.

Purging the cooler may have to be done as often as once a week, and then again not for two or three months. A cooler needs purging under the following conditions: (1) If both gage-cocks are frosted, as with normal charge; (2) if the cooler pressure is only a little, if any, in excess of the brine temperature; (3) if, on opening the cooler gage, the liquor looks watery and not soapy, then the indication is that some aqua has worked over into the cooler and that the cooler needs purging.

To purge the cooler, close the expansion and gas-outlet valve and open the purge valve leading out of the bottom of the cooler. This will drain all the liquor out of the cooler into the absorber. The pressure will rise in the cooler at first, but after fifteen minutes, will gradually fall. During the purging the pump should be run slowly and the liquor be allowed to accumulate in the absorber, which will prevent the pump from losing its suction. When the cooler has been well drained out, open the expansion valve for about thirty seconds. This will force the remaining liquor out of the cooler. After this is done two or three times and when the cooler pressure drops back to zero, the cooler has been completely purged. The machine can then be started, care being taken not to open the expansion valve too wide at the start.

The brine should preferably be made of chloride of calcium rather than from ordinary salt; it is more expensive than the latter, but does not have any corrosive action upon either pipes or valves and does not deposit solids in the coils. The gravity of the brine should occasionally be tested with the hydrometer. Brine of a specific gravity of 1.165 is safe at 6 deg. F. above zero; that of 1.200 does not freeze until it gets about 14 deg. F. below zero. If the brine is weak, there is liability of the cooler coils freezing, which would be indicated by a sudden stoppage of the brine pump. In such event immediately close the gas valve and open the expansion valve wide for at least five minutes. This should sufficiently heat the brine to thaw it and permit the pump to start.

To thaw freezer cooler, close the gas line from the cooler to the absorber and open the expansion valve wide and warm gas from the condenser will thaw out coils. Never allow the brine pump to stop when the cooler is in operation, as this is one of the causes of freezing.

When running at full capacity, the ammonia pump should circulate about ⅝ gal. of liquor to the ton of refrigeration. If a steam pump does not run steadily, but with a jerk, it is probable that there is some difficulty with the valves. These are of hard rubber or steel and should be inspected occasionally. If they become pitted in the crossbars of the valve seats, it is best to replace them with new valves. Pump rods should be kept smooth and true; any difficulty experienced in properly packing the pump end can usually be traced directly to the fact that the rod has become worn, tapering from the middle to the ends, which has a tendency to burst the stuffing-box by the wedge-like action of the rod. A properly packed box requires only a very light pressure of the gland and follower on the packing to prevent leakage. A small quantity of oil is to be used occasionally to lubricate the rod. If it is found that the pump is air-bound or gas-bound, it can be relieved by closing the suction and discharge valves and emptying the pump into a bucket of water through the pumping-out valve at the discharge of the pump. The suction valve should then be slowly opened and the pump allowed to fill with ammonia.

A regulator is provided on all modern steam ammonia pumps. It is connected top and bottom with the absorber, the liquid level line of the regulator being placed on a line with the liquid level desired in the absorber. It is of the ball-float type, the rise and fall of the ball operating the steam-inlet valve to the pump. In case the regulator does not work properly, it may be due to a stoppage in the lines to absorber or the collapse of the float. The float is of a special spun-steel type and should be purchased of the manufacturer. The regulator connections are provided with the valves on inlet and outlet, which should be closed in case it is desired to examine the float.

To get good results it is important to keep condenser, absorber and rectifier coils clean. They should be cleaned at least twice a year or oftener if possible.

Helical coils can be cleaned by blowing air and water through each coil or using some good coil compound. Tubular "coils" can be cleaned by using an ordinary tube scraper and brush. After the tubes are thoroughly cleaned it is well to coat them with noncorrosive solution, which is especially prepared for this purpose.

When the charge of ammonia is too weak, the process of distillation will not be uniform and continuous, and difficulty will be experienced in maintaining a reserve of anhydrous ammonia in the receiver, and an increased steam pressure will be required on the generator to distill over the ammonia. When this is the case, the ammonia charge must be strengthened. It should always be remembered that a weak charge entails a loss in the capacity of the machine, and that more fuel and more condensing will be required to do the work.

When starting the machine, some trouble will be experienced for a few days on account of the pressure of air in various parts. The same is true when at times the machine is recharged with aqua ammonia, which holds a considerable amount of air in solution. The air is gradually driven off from the aqua ammonia during the process of distillation and finds its way through the machine. A hose should be attached to the air valves on the absorber and receiver and dipped into a bucket of clean, cold water. If the gas coming from the hose is at once absorbed by the water with a sharp rattling noise, and no bubbles rise to the surface, and the water turns slightly bluish, all the air is out; if, however, bubbles continue to rise there is still air in the machine. When there are indications of a large amount of air in the machine it is best to shut down and blow out the air in one operation. At other times it is sufficient to slightly open the air-cocks and carefully watch for air and ammonia.

The presence of air in the machine is generally indicated by an excessive and misleading pressure in the generator and by the inability of the absorber to properly and promptly absorb the gas. It thus affects both the economy and the capacity of the machine.

With proper care and attention and by a systematic inspection of all joints, cocks and valves at convenient times, no ammonia leaks should occur; but in case of any, however small, they should be stopped at the first opportunity; these leaks are usually of anhydrous ammonia gas, and loss of ammonia rapidly diminishes the capacity and efficiency of the machine.

When the sense of smell is not sufficient to definitely locate a leak, the same can be found by holding a glass rod, moistened with muriatic acid, at or near the place of the suspected leak. A bluish-white cloud forms at the leak and immediately discloses its location. The same results can be obtained by holding burning sulphur near the leak.

Qualifications of Employees in Russian Refrigerating Industries

At a meeting of the Council of the Russian Refrigerating Committee of the Association Internationale du Froid the following resolutions, here given in part, were adopted, according to the association's bulletin.

The committee for the propaganda of knowledge on artificial refrigeration adopted the following classification concerning conditions with which employees in different sections of these industries shall comply:

Machine Section—Besides being experienced as regards the running of steam engines and dynamos, the machinist and his assistants must be perfectly familiar with the construction and operation of refrigerating machines, not only as regards the machine itself, but all its parts (condenser, coils, manometers, recording instruments, thermometers, etc.), as well as the starting of a machine and its supervision during operation. They shall have sufficient rudimentary knowledge on this subject to enable them to draw up plans, replace bolts, clamps, etc., and understand a technical description of a machine.

Cold-Storage Warehouse—The first and second inspectors shall have a good conception of cold-store construction, the operation of various refrigerating systems and their different organs and recording instruments for temperature and humidity and understand thermometer and hygrometer indications. They shall have charge of the supervision of rooms, doors and ventilating appliances and are expected to be able to distinguish the different grades of goods stored in the cold-storage plant; they shall also be familiar with the various packing systems and know the proper storage temperature for different kinds of perishables.

Icehouses—Workmen making a specialty of ice making will be employed in this branch of the business. An accounting system especially adapted for icehouses will be used.

Railway Icing Stations—Employees shall possess enough instruction on this subject to understand the rational construction and operation of icehouses and factories, ice making, ice loading into refrigerator cars, etc.

Specialists in Refrigeration (Technics and Engineering)—The general direction or management of a cold store shall be confided exclusively to a refrigerating engineer or a specialist in refrigeration. As regards the construction of a cold store, it shall be intrusted only to a refrigerating engineer.

In order to manage a cold-storage warehouse, a technical engineer must have received special instruction as regards artificial refrigeration, from both a theoretical and a practical standpoint and especially as regards the management of refrigerating machines; he shall further be familiar with the requirements of all parts of a cold store.

For agriculturists wishing to make a specialty of artificial refrigeration, a thorough knowledge of all branches of this subject is required, especially as regards the storage and transport of different kinds of perishables; inspection of all parts of the plant at regular intervals shall be organized in order to obtain the best results from the standpoints of temperature, hygrometry, etc.

Every specialist in refrigeration shall be perfectly familiar with the commercial part of this industry.

A list, appended, gives the names of schools, institutions and courses which applicants may attend in order to fit themselves for service in the refrigerating industry.

Price-Fixing and Coal Quality

Ever since coal prices were fixed by the Fuel Administration, long before the coal shortage became acute, there have been complaints of the poor quality of the coal delivered, and since the shortage these complaints have been getting more strenuous. A big coal man was asked the reason back of this recently, and he answered: "Well, for instance, we have two coal properties. One produces an unusually good quality of coal, of high heating value, with very little slag or sulphur. Before they fixed prices we commanded about forty cents a ton above run-of-mine prices for this coal, which we sold, on tests of its heating value, to public-service corporations and other institutions which were willing to pay extra for quality. Our other mine produced a much inferior grade of coal, which, however, was easier to mine. But the Fuel Administration, in fixing prices, said in effect, 'Coal is coal,' and fixed the same price for both mines. What's the answer? Naturally we are tempted to concentrate our surplus producing power on the poorer mine. Probably there are plenty of other coal men in exactly the same situation."—*The New York Times.*

Engineers in Government Service

Engineering Council, through its American Engineering Service Committee, has during the past few months supplied to various Government departments and bureaus in response to their requests, several thousand names of engineers from which men were to be selected to fill a great variety of positions in uniformed and civilian service for Army and Navy and other branches of the Government's activities in connection with the war, as well as for indirect service for manufacturers and contractors engaged upon Government war work.

To meet these demands the American Engineering Service Committee has assembled in its offices in the Engineering Societies Building, New York, extensive lists and much detailed information concerning engineers in all branches of the profession throughout the length and breadth of the land. It will readily be appreciated that if these lists are to be maintained in the most useful condition to the Government and to Engineering Council, the committee should receive promptly information concerning each engineer who has gone into any kind of Government service, direct or indirect, so that a record may be made on his cards in the committee's office.

Engineers reading these lines, to whom this request applies, are urged to send at once their names, present addresses and occupations in the Government service, with brief statement as to whether or not they are available for other service, to American Engineering Service Committee, Room 901, 29 West 39th St., New York. Other readers are asked to bring this request to the attention of such engineers or to send information directly to the committee.

Engineering Council is an organization of national engineering and other national technical societies of America of approximately forty thousand members, each member society having duly elected representatives therein, created to provide for the proper consideration of subjects of general interest to engineers and the public and for united action upon matters of common concern to engineers in all branches of the profession.

New York N. A. S. E. Offers Aid to Fuel Administrator

The following is the copy of a letter addressed to the New York State Fuel Administrator by the Combined Associations of Manhattan, Bronx and Queens National Association of Stationary Engineers:

Mr. A. H. Wiggin,
State Fuel Administrator.

Dear Sir: As the Government has for some time been considering ways and means to promote the economical consumption of fuel wherever and whenever used for the generation of heat, light and power, the National Association of Stationary Engineers, recognizing its responsibilities and duties in the present fuel crisis, hereby tenders its services to the various fuel-conservation commissions to cooperate in any capacity as their judgment may dictate.

We are anxious to demonstrate a true and patriotic spirit of coöperation to our Government in its efforts to bring our fighting forces up to the highest standard of efficiency.

We note that you have appointed a committee to report back to you on ways and means whereby the consumption of fuel may be reduced. If this is so, may we not suggest that men be represented on this committee who are actually in touch with the fuel-burning situation at all times, men who have been trained through the hard knocks of experience in fuel burning from the ground up, men who have come from the fireroom to the actual charge of the operation of the largest steam, electrical and refrigeration plants in the country?

This organization represents eleven subordinate locals in Greater New York, who are affiliated with nearly 25,000 operating engineers in the country.

Conservation of fuel does not only mean the proper burning of a combustible or the reduction of power consumption. It also means the proper application of steam through the various appliances and apparatus that are auxiliary to every power plant. In many plants changes could be made that would result in considerable saving of fuel if the necessary changes in equipment were made as suggested by the chief operating engineer.

May we further suggest that if your time permits, a personal interview be granted to a committee representing this organization, where the various phases of the question could be discussed.

Yours very truly,
D. LARKIN,
President.

Discharging Warm Water in Stream

Where warm or hot water or steam is discharged into a stream in the winter time, when ice has formed on the surface and is being used by skaters, the owner of the plant is legally bound to take all reasonable precautions to guard against drowning of persons skating and exercising due care for their own safety. This should be done by erecting barriers where the ice is rendered unsafe, or by other suitable warning of danger that may not be appreciated by persons on the ice.

This statement of the law is supported by the recent decision of the Michigan Supreme Court handed down in the case of Parsons vs. E. I. du Pont de Nemours Powder Co., 164 Northwestern Reporter, 413. In this case, the court upholds liability of defendant for drowning of a boy who skated upon ice which had been rendered insecure by warm water discharged into a stream from defendant's plant, in the absence of proof showing that the boy was guilty of contributory negligence. It is decided that unless such proof be made, it must be presumed that the boy used due care for his own safety.

Personal Mention

Most men have limitations as to the quantity, quality and variety of work they can conduct with credit. Not so with J. C. McCabe, head of the Department of Safety Engineering, Detroit, Mich. The city fathers have already given him twelve distinct duties, and there are rumors of more to follow. In fact, when there is a choice bit of engineering work to do, testing or what not, requiring originality and unusual ability, an appropriation is made and McCabe is the man to do the work. The present activities of the department are as follows: 1, boiler inspection; 2, licensing of steam engineers; 3, inspection of ice-making and cooling plants; 4, inspection of elevators for construction, freight or passenger service; 5, analysis of gas; 6, use, handling, storage and sale of inflammable liquids and their products; 7, smoke inspection; 8, plumbing inspection (pending); 9, inspection of air tanks; 10, use of acetylene and calcium carbide; 11, testing of inflammable liquids and such other duties as the common council shall assign; 12, purchasing and handling coal for city departments and, in the recent shortage, diversion of city coal for industrial use.

A New Fuel—"Carbocoal"

Announcement is made of the invention of a commercial process for converting bituminous coal into a fuel called "Carbocoal," the equivalent of anthracite. A feature of the process is that by it there is recovered valuable byproducts from the coal that in present practice are wasted. The Smith process, as it is termed, takes the raw coal and separates the oils from the carbon and in turn presses the carbon into convenient shape for use.

This fuel is said to contain only 1½ to 4 per cent. of volatile matter and consists mainly of fixed carbon; in combustion it is smokeless, ignites with comparative ease, burns freely and under all draft conditions, is dustless, clear and uniform in size and quality. It is said to be suitable for use in marine and stationary boilers, for domestic use, kilns and gas producers. This fuel is to be put on the market by the International Coal Products Corporation. No address is given.

To keep polished iron or steel from rusting, mix five parts of fat oil varnish with four parts of spirits of turpentine. Apply with a sponge.

New Publications

DIRECTIONS FOR SAMPLING COAL FOR SHIPMENT OR DELIVERY—By George F. Pope. Technical Paper 133, Department of the Interior, Bureau of Mines.

This is another one of the many publications of the Bureau of Mines on sampling coal. It deals with the time of sampling, the collection of gross samples, the size of samples, storage of gross samples, sampling from wagonloads, carload sampling, ship or barge sampling, and with the preparation of the gross sample; that is, crushing, halving and quartering. For the power-plant man this paper is probably the most useful of all that the Bureau has published on this subject. It may be had free by addressing the Director of the Bureau, Washington, D. C.

HYDRO-ELECTRIC POWER STATIONS. By Erie A. Lof and David B. Rushmore. Published by John Wiley & Sons, Inc., New York, 1917. Cloth; 6 x 9 in.; 822 pages; 408 illustrations; 66 tables. Price $6.

Water-power developments have become so closely allied with electrical engineering that it is practically impossible to give due consideration to the former without considering the latter; or, as the authors have pointed out in the preface of this book, "The work of planning, building, operating a hydro-electric power development requires a full understanding of the economic factors which enter into the problem and a thorough knowledge of both the hydraulic- and electrical-engineering sides of the subject." It is with these elements in mind that the authors have prepared this work. The book is divided into 11 chapters and 3 appendixes. Chapter 1 is a general introduction and gives data on the history of water power and electrical developments, available and developed water powers in the United States, primary power and its uses, power from inland waterways, etc. Chapter 2 deals with properties of water, rainfall, disposal of rainfall, stream flow, energy of flowing water and convenient equivalents. Chapter 3 considers the different kinds of water-power developments. Chapter 4 treats of dams, flashboards, fishways, intakes, etc. Chapter 5 is on water conductors, water-hammer and surge tanks, gates and valves. Chapter 6 deals with storage reservoirs. Chapter 7 takes up the problem of power-house design, embracing buildings, arrangement of apparatus, transportation and erection, starting up, general precaution, drying-out equipment, etc. Chapter 8 deals with the various types of turbines and their characteristics; governors, their operation and methods of control; pressure regulators or relief valves, water-flow meters, water-stage registers. Chapter 9 takes up the subject of electrical equipment. This chapter is very comprehensive, covering 373 pages, and gives consideration to practically every piece of electrical equipment entering into a hydro-electric power plant. Chapter 10 is also very comprehensive, occupying 100 pages and embraces the economical aspects of water-power development, such as preliminary considerations, general guide for the compilation of water-power reports and the securing of field data. This particular section is illustrated with different forms used for obtaining the foregoing data. Another very important section of this chapter is that on costs of hydro-electric power plants. This latter section gives cost data on 17 different hydro-electric power stations, varying in size from 600- to 200,000-kw. capacity. Chapter 11 gives consideration to the problem of organization and operation. Appendix 1 gives a reference to the descriptions of hydro-electric power systems in North America that have been published in the engineering publications of the United States and Canada; Appendix 2 is a table giving principal data on transmission systems operating at 70,000 volts and above; Appendix 3, standard testing code for hydraulic turbines.

In this book an endeavor has been made to describe the most recent engineering practice, and a considerable amount of information that has not heretofore been available is included. The authors, for many years being connected with one of the largest power-plant equipment manufacturing companies in the world, have had an excellent opportunity to collect valuable information over a wide range of experience. The book is not a mathematical treatise, although formulas are given where necessary, but is a practical presentation in readable language of the problems that must be solved in connection with the construction, management and operation of hydro-electric power stations. Although written for the engineer and engineering students, a great deal of the material is presented in such a way that it can be easily understood by the practical power-plant operator, and should be well received by all those who have to do with hydro-electric power plants.

COLLAPSE OF SHORT THIN TUBES

Bulletin No. 99 of the University of Illinois Engineering Experiment Station contains the results of a series of experiments on the collapse of short thin tubes, made by Prof. A. P. Carman of the department of physics. The purpose of these tests was to find an equation by the application of which the pressure required to collapse a tube can be calculated when the dimensions of the tube and the elastic properties of the material are known. The bulletin gives a brief summary of earlier experiments on collapsing pressure, such as those of Fairbairn, Stewart and others, together with the formulas developed by these investigators. Then follow the description of the testing apparatus used by Professor Carman, the graphical and tabulated results of his experiments, and his conclusions. The data as given represent the results of the collapse of about 150 tubes. The majority of these were cold-drawn steel tubes from 1 to 3 in. in diameter. The remainder were of brass, aluminum, glass and hard rubber. The number of experiments on the last two materials, however, was too small to justify much generalization. The glass tubes, on collapsing, were reduced to a fine powder. The metal tubes collapsed in two, three, or four lobes, depending on the length. Copies of this bulletin may be obtained gratis by addressing the Engineering Experiment Station, Urbana, Ill.

DETERMINATION OF MOISTURE IN COKE

Technical Paper No. 148, of the Bureau of Mines, Department of the Interior, deals with The Determination of Moisture in Coke, and is written by A. C. Fieldner and W. A. Selvig. The following is from the summary of the bulletin:

1. Investigation shows that the influence of temperature, time, humidity of drying atmosphere, and fineness of sample on the determination of moisture in coke may be varied over a considerable range without affecting the result appreciably.

2. Oven temperatures ranging from 105 to 200 deg. C. produced a maximum variation in moisture of not exceeding 0.3 per cent.

3. Coke can be dried to "constant weight" without any gain in weight taking place.

4. The circulation of air dried by sulphuric acid, through the oven atmosphere, as specified for coal analysis, is unnecessary, there being no measurable difference of results between circulating perfectly dry air through the oven and using in the oven the natural circulation of air from the room.

5. Moisture can be determined quickly with adequate accuracy of 0.5 per cent. by simply heating to constant weight a large sample of lump coke, in any convenient oven or on a stove, hot plate or steam coil at a temperature of 100 to 200 deg. C.

Because of its simplicity and flexibility, this method may be used advantageously at points when coke shipments are sampled.

Personals

S. D. Levings has resigned as Eastern representative of the automobile equipment department of the Westinghouse Electric and Manufacturing Co.

Engineering Affairs

The Association of Iron and Steel Electrical Engineers announces the following meetings: Cleveland District Section, Feb. 23, at Hotel Statler, at which B. W. Gibson, of the Carnegie Steel Co. will deliver a paper on "Generation, Distribution and Consumption of Power." The Philadelphia Section on Mar. 1, at the Majestic Hotel; John S. Rowan, of the Rowan Controller Co., Baltimore, Md., will present an illustrated paper on "Standardized Mill Table Controllers." A joint technical session, A. I. E. E. and Cleveland District Section, A. I. & S. E. E. will be held on the evening of Mar. 8, of which complete announcement is to be made later. The Pittsburgh Section's regular meeting will be held on Mar. 16 at the Hotel Chatham.

The Association of Ohio Technical Societies was organized at a conference of the engineering societies of the state held at Columbus, Jan. 29, with Clyde T. Morris, professor of civil engineering, of Ohio State University as president, and C. E. Drayer, of Cleveland, as secretary. The societies included in the association embrace every local society and local section of the national societies, twelve in number, as follows: Cleveland Association of Members of the A. S. C. E.; Cleveland Enginering Society; Cleveland Section, American Institute of Electrical Engineers; Columbus Chapter, American Institute of Architects; Engineers' Club of Cincinnati; Engineers' Club of Columbus; Engineer's Club of Dayton; Engineers' Club of Youngstown; Northwestern Ohio Surveyors' Association; Ohio Engineering Society; Ohio Society of Mechanical, Steam and Electrical Engineers; Toledo Society of Engineers.

Miscellaneous News

A Boiler Exploded on the lease of the Ohio Co. in Lawrence Co., Ill., on Jan. 29, instantly killing one of the oil workers and probably fatally injuring another. The cause of the explosion is not known.

Business Items

Fred F. Woolley, president, and John T. Sibley, chief engineer of the Hammel Oil Burning Equipment Co., Inc., of Providence, R. I., are now covering the southern power plant field from the Carolinas to Cuba and along the Gulf of Mexico to New Orleans. They are receiving numerous large orders and report that fuel oil burning in this territory will be active. Their temporary headquarters for this district is at Tampa, Fla.

The Westinghouse Electric and Manufacturing Co's. automobile equipment department has removed its manufacturing operations to the company's Newark works, Plane and Orange Sts., Newark, N. J. At this works the company has for many years been manufacturing small motors and instruments of accuracy and precision. At the same time the general sales office of this department will be moved to 110 West 42d. St., New York City, where the Eastern District Sales Office will also be located.

Trade Catalogs

Industrial Heating Apparatus. Westinghouse Electric and Manufacturing Co., East Pittsburgh Penn. Catalog 8-E. Pp. 32; 8 x 11 in.; illustrated. Describes the many different types of industrial heaters built by this company and their application.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn., has issued two new bulletins illustrating and describing Simplex "Seatless" Blow-Off Valve and Simplex Pipe-Joint Clamp, also a pamphlet listing some of the users of Simplex blow-off valves and containing some sample reports and photographs of installations.

Bakelite Micarta-D Gears and Pinions. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn. Booklet 1579-A. Pp. 12; 8 x 11 in.; illustrated. Gives technical information regarding this type of gear, such as methods of attaching to the driving shaft, that have proved suitable for these gears, tables of pitch, teeth and other gear data, formulas for horsepower rating, amount of power that can be transmitted through a press fit and for calculating other variables in gear practice.

The Moloch Stoker Co.'s Type H catalog. The Moloch Stoker Co., Continental and Commercial National Bank Building, Chicago. Pp. 30; 8½ x 11 in.; illustrated. This catalog is quite unusual in character, in that it presents the subject in a most common-sense way. Beginning with a paragraph entitled "The Economy of Mechanical Firing" and proceeding in a logical and natural manner to a clear, although nontechnical description of the apparatus featured. The text matter proceeds in a logical manner to a well-developed conclusion in which the advantages of the Moloch stoker are summarized. The catalog is well illustrated throughout with assembled and detail views of the various parts and mechanism, as well as numerous typical installations.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago
Buckwheat ..	$4.60	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.10	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	3.90	.....	.....	.....
Barley	3.60	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Bituminous not on market.

	F.o.b. Mines*		Alongside Boston†	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago
Clearfields....	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets...	.....	3.10—3.85	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago
Pea	$5.05	$4.00	$5.80	$7.25—7.50
Buckwheat ..	4.30—5.00	2.75	5.50—5.80	6.25—6.50
Barley	3.25—3.50	1.95	4.00—4.25	3.50—3.75
Rice	3.75—3.95	2.20	4.50—4.80	4.50—5.00
Boiler	3.50—3.75	220	.....	3.25—3.50

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide		
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago	Independent One Year Ago
Buckwheat ..	$3.15–3.75	$2.50	$3.75	$3.40	$4.15
Rice	2.65–3.65	2.10	3.65	3.00	3.35
Boiler	2.45–2.85	1.95	3.55	3.15	....
Barley	2.15–2.40	1.85	2.40	2.05	2.35
Pea	3.75	2.80	4.65	3.70	....

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Prepared sizes	$2.60—2.80	$3.05—3.25
Mine-run	2.40—2.60	2.40—2.60
Screenings	2.10—2.30	2.10—2.30

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago	Feb. 14, 1918	One Year Ago
6-in. lump..	$2.65-2.80	$3.25-3.50	$2.65-2.80	$3.25-3.50	$2.65-2.80	$2.50-2.75
2-in. lump..	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Steam egg ...	2.65-2.80	.....	2.65-2.80	.....	2.65-2.80	.....
Mine-run ...	2.40-2.55	3.00-3.25	2.40-2.55	3.00	2.40-2.55	2.25-2.50
No. 1 nut	2.65-2.80	3.25-3.50	2.65-2.80	3.25-3.50	2.65-2.80	2.35-2.75
2-in. screen .	2.15-2.30	3.00-3.25	2.15-2.30	2.75-3.00	2.15-2.30	2.25-2.50
No. 5 washed	2.15-2.30	3.00	2.15-2.30	2.75-3.00	2.15-2.30	2.50

Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ark., El Dorado—The Arkansas Light and Power Co. plans to build an 18 mile transmission line from here to Junction City. J. L. Longino, Arkadelphia, Ch. Engr.

Fla., St. Petersburg—The St. Petersburg Lighting Co. plans to increase the capacity of its lighting plant. Estimated cost, $40,000.

Ga., Albany—The Albany Power and Manufacturing Co. is in the market for a 185 lb. hand fired 600 hp. water tube boiler. E. S. Killebrew, Supt.

Ga., Jeffersonville—City plans an election to vote on $15,000 bonds for the erection of an electric-lighting plant. W. Goodlee, Macon, Engr.

Ind., Monterey—The Monterey Electric Light and Power Co. is having plans prepared by C. Nielson, Engr., 154 West Randolph St., Chicago, for the erection of a 1 story, 50 x 125 ft. power house.

Ind., Williamsport—City plans to install new machinery in its plant including a 3 phase generating unit, directly connected, to replace the single phase unit now being used. B. Scott, Supt.

Kan., Colby—City voted $30,000 bonds for improvements to its electric-lighting plant. C. V. Parrott, City Clerk.

Kan., Wellsville—The Wellsville Electric Light, Power and Ice Co. plans to purchase 5 or 10 kva. transformers soon. C. A. Smith, Mgf.

Mass., Palmer—The Central Massachusetts Electric Co. plans to issue $200,000 additional stock; the proceeds will be used to build additions and improvements to its plant. H. M. Parsons, Gen. Mgr.

Minn., Pine City—The Eastern Minnesota Power Co. plans to build a 10 mile transmission line and install a 500 kw. turbine in its plant. R. P. Allen, Mgr.

Mo., Oregon—City plans to build an electric transmission line from here to St. Joseph in order to secure electricity from there. M. R. Martin, Supt.

Neb., Dalton—The Village Board will receive bids until February 26 for the erection of a power plant and the installation of the necessary machinery. R. D. Salisburg, 1415 East Colfax Ave., Engr.

N. Y., Rochester—The Department of Public Works will soon receive bids for the erection of a central heating plant and will install a heating boiler and coal and ash handling machinery. Estimated cost, $75,000.

N. Y., Utica—The West Brewery is in the market for new machinery including motors, two 150 hp. boilers, belting and conveying and bottling machinery.

N. C., Rocky Mount—City is having plans prepared by J. N. Eley, Engr., Empire Bldg., Atlanta, Ga., for the erection of an electric-lighting plant. New equipment including a 300 hp. Heine type boiler, will be installed.

Ohio, Akron—The Northern Ohio Traction and Light Co., Hamilton Bldg., will soon receive bids for the erection of a power plant and meter building. Estimated cost, $100,000. F. C. Warner, 767 Hippodrome Bldg., Cleveland, Arch.

Ohio, Chardon—City voted $25,000 bonds to rebuild and improve its electric-lighting plant. New electric-generating units and an entire change of system from 133 to 60 cycle, will be installed. Noted Nov. 27.

Ohio, Cleveland—The Board of Education will receive bids until February 25 for the installation of three 350 hp. water tube boilers, stokers for same, 2 boiler feed pumps and one 150 ft. radial brick chimney, 96 in. diameter for its central heating plant.

Ohio, Wellington—The Board of Trustees of Public Affairs is in the market for flywheel, 40 x 10 in. to 14 x 6 or 6½ in. bore to weigh about 1000 lb. C. E. Gadfield, Supt.

Penn., Philadelphia—The Colver Electric Co. has petitioned the Public Service Electric Co. for authority to issue $25,000 additional stock; the proceeds will be used to build additions and improvements to its plant.

Penn., Reading—The Metropolitan Edison Co. plans to issue $97,500 in bonds; the proceeds will be used to build additions and improvements to its plant.

Tex., Dallas—The Dallas Light and Power Co. plans to build an electric transmission line from here to Norwood. R. C. Brooks, Supt.

Va., Richmond—The Richmond, Fredericksburg and Potomac R.R. is having plans prepared for the erection of an addition to its engine house. Estimated cost, $20,000. W. D. Duke, Gen. Supt.

Wash., Seattle—The Union Lake Co. plans to build a third addition to its power plant. Estimated cost, $600,000. K. J. D. Ross, Supt.

Ont., Stratford—The G. McLagan Furniture Co. is in the market for a horizontal steam boiler, 16 ft. long and 6 ft. in diameter.

Que., Warwick—The Warwick Overall Co. is in the market for a 20 hp. electric motor.